

To examine the effects of DVD exercises on exercise tolerance in
participants of the Canterbury home-based pulmonary
rehabilitation programme

A thesis submitted in fulfilment of the requirements for the Degree of

Master of Health Sciences

University of Canterbury

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Acknowledgements

I wish to express sincere appreciation to Professor Ray Kirk and Dr Sarah Lovell for their assistance in the preparation of this manuscript. Special thanks to Kim Sinclair-Morris (Director of Canterbury Clinical Network), Deborah Callahan (Canterbury Clinical Network Integrated Services Manager), and colleagues at the Canterbury Clinical Network and Pegasus Health for their support at work and in my study. Sincere appreciation is also due to the Canterbury Pulmonary Rehabilitation Working Group members for their valuable contribution in the conceptualisation, development, and continuous improvement in the home-based programme study. I also wish to express sincere appreciation to all the participants who offered their time to contribute to the pilot home-based rehabilitation study. Finally, a big thank you to my wife, Ruth, for her never ceasing support in my study over the last few years and my two boys, Isaac and Jordan, here is baba's little input into making the health system of tomorrow better for you two.

Abstract

The pulmonary rehabilitation programme is an evidence-based intervention to treat and manage people living with long-term breathing conditions, mainly chronic obstructive pulmonary disease (COPD). Pulmonary rehabilitation is a structured eight-week long programme, which requires participants to attend the programme twice a week, for two hours each session. The two-hour session is broken down to one hour of exercise and one hour of education. The literature suggests that the pulmonary rehabilitation is useful in improving self-management skills, improving fitness levels, and reducing social isolation to the people living with chronic respiratory illnesses. Despite the strong evidence behind pulmonary rehabilitation, the programme is still not well utilised by health professionals and people living with chronic respiratory illnesses. There are many reasons for not participating in a pulmonary rehabilitation programme, such as not understanding the content of pulmonary rehabilitation, transportation difficulties, or work commitments. This study helped the pulmonary rehabilitation governance group to explore a different delivery model and evaluate the effect of this alternative pulmonary rehabilitation delivery model: the home-based pulmonary rehabilitation.

Participants (n= 21, 11 males: 10 females, mean age of 68.76 years, 71% of the participants identified themselves as New Zealand European and 14% identified as Māori) were recruited from the existing pool of withdraw referrals, that is people who had been referred to the programme but never attended or completed a programme. These participants had been offered pulmonary rehabilitation in the past but either declined or had been unable to participate in a programme. All the participants received a home visit from the physiotherapist for assessments, education, and to set up the DVD exercise regime. The home-based programme lasted for eight weeks and each participant received a weekly telephone call from a health professional to check on the participant's exercise progress. The Chronic Respiratory Questionnaire (CRQ), COPD Assessment Tool Score (CATS) and EQ-5D questionnaires were used to evaluate the quality of life and self-management before and after the home-based programme. The Hospital Anxiety and Depression Scale (HADS) was used to assess participants' psychological wellbeing. Finally, one-minute sit-to-stand tests were carried out before and after the programme to identify any change in the participant's exercise tolerance. The collected data were

analysed and compared to the control, centre-based pulmonary rehabilitation data, using a 2-tail *t*-test to determine statistical significant difference.

The home-based pulmonary rehabilitation programme performed no worse than the gold standard centre-based pulmonary rehabilitation in the majority of the outcome measures used. The home-based pulmonary rehabilitation was better at reaching out to younger, male, and Māori participants when compared to the control, the centre-based pulmonary rehabilitation. The majority of the primary and secondary outcome measures showed that the home-based pulmonary rehabilitation performed as well as the control, the centre-based pulmonary rehabilitation programme, in making significant improvements. But in fatigue management, exercise tolerance, and EQ-5D, the control, centre based group was able to achieve superior outcomes when compared to the home-based pulmonary rehabilitation.

This study has successfully demonstrated that the home-based pulmonary rehabilitation is an effective alternative to the gold standard centre-based pulmonary rehabilitation when managing people living with COPD. Despite the fact that the home based group participants were recruited from a less favourable pool of participants, the withdrawals, the home-based pulmonary rehabilitation was an enabler to positive and significant improvement to the participants in all outcome measures. The main weaknesses of the home-based pulmonary rehabilitation lies with the reduced clinician supervision of the participant's exercise regime and the lack of social interaction in this delivery model. The author believes, however, that with continuous service review, research and development, these weaknesses can eventually be effectively managed and minimised.

Chapter 1: Introduction

Introduction- a classic Chronic Obstructive Pulmonary Disease patient scenario

Jason is a 60 year old semi-retired beef farmer living in Darfield. Five years ago, he started noticing a gradual increase in his level of shortness of breath while he was working on the farm. He was still a cigarette smoker (15 cigarettes a day) at the time and had been a smoker for the last 45 years. Two years ago, he was diagnosed with chronic obstructive pulmonary disease (COPD) through a breathing test known as spirometry. Jason has a good relationship with his General Practitioner (GP). He was very keen to learn more about this newly diagnosed medical condition and discover ways to improve his breathlessness. Jason discussed his breathlessness concerns with the GP and as a result of the discussion, the GP referred Jason to the Community Pulmonary Rehabilitation Service. The Community Pulmonary Rehabilitation team contacted Jason but, due to his work commitments and rural residence, Jason was not able to attend a programme. A clinic letter was generated to inform the GP that this Pulmonary Rehabilitation referral was closed for now due to Jason's unavailability.

The above story is a classic scenario that the Community Pulmonary Rehabilitation team faces on a weekly basis. And to date, there is no clear pathway or alternative service that the team could offer to people like Jason who are younger, still working and newly diagnosed with COPD. For this reason a solution for COPD patients like Jason needed to be identified and implemented, and this is the topic of the thesis.

What is COPD?

Chronic obstructive pulmonary disease is a chronic progressive lung illness characterised by obstruction in the airway that cannot be fully reversed. In people living with COPD, their airways will be narrowed. The symptoms quite often include breathlessness on minimal exertion and an increased sputum production. The recent Global Initiative for Chronic Obstructive Lung Disease (often referred to by the acronym GOLD) defines COPD as “a

common preventable and treatable disease, which is characterised by persistent airflow limitation that is usually progressive and associated with abnormal inflammation response of the lung to noxious particles or gas” (GOLD website, 2016). Barnes, Rennard, and Thomson (2009) estimated that 70-80% of the COPD cases were caused by cigarette or tobacco smoking. Other causes include environmental smoke inhalation (such as industrial fumes, air pollution, occupational exposure to dust, and indoor biomass fuel burning) and genetic abnormalities (such as alpha-1 antitrypsin deficiency) (Soriano & Lamprecht, 2012). There is a variety of common treatments for people living with COPD which include pulmonary rehabilitation, medications, and long-term oxygen therapy.

It is anticipated that people living with COPD will benefit from a PR programme, the focus of this thesis. Pulmonary rehabilitation programmes have also been mentioned in the literature to be effective with other chronic respiratory conditions such as asthma, interstitial lung diseases, pulmonary artery hypertension, non-cystic fibrosis bronchiectasis, and non-small cell lung cancer, by improving quality of life, exercise performance, and fatigue levels (Holland, Wadell, & Spruit, 2013).

The burden of COPD

Soriano and Lamprecht (2012) indicated that COPD has become one of the major health burdens in the world. In 2012, an estimated 210 million people were living with COPD and it caused the death of at least 2.9 million people worldwide. It was estimated that 1.1 billion people in the world were current smokers, the major cause of COPD. The authors also pointed out that COPD was the fourth leading cause of death since the year 2000 and conservative projections suggested that by the year 2020, COPD would become the third leading cause of death worldwide (Soriano & Lamprecht, 2012; WHO COPD website, 2016).

In 2010, it was projected that COPD had had a significant impact on the United States’ health system and productivity, costing as much as USD 49.9 billion a year (Mannino et al., 2015).

The amount was broken down to USD 29.5 billion of direct medical costs, USD 8 billion on

indirect morbidity cost (lost productivity cost due to illness) and USD 12.4 billion on indirect mortality costs (loss of productivity due to premature death). The main reason for the high economic cost in treating people living with COPD is due to its complexity and systemic influences on the body (Baty et al., 2013). Baty et al. (2013) reported a cluster of comorbidities (other medical conditions) are commonly seen in people living with COPD: cardiovascular diseases (ischaemic heart disease, heart failure, etc.), respiratory tract diseases (obstructive sleep apnoea, pneumonia, etc.), metabolic diseases (type II diabetes, dyslipidaemia, etc.), haematological diseases (anaemia, pulmonary embolism, etc.), musculoskeletal diseases (muscle dysfunction, osteoporosis, etc.), gastro-intestinal diseases (reflux, liver cirrhosis, etc.), renal diseases (renal dysfunction), psychiatric diseases (depression, anxiety, etc.), and cancers (lung, pancreas, etc.). Mannino et al. (2015) went a step further by quantifying the percentages of each of the major comorbidities and they reported from their retrospective observational study, 34.8% of people living with COPD had cardiovascular disease, 22.8% had diabetes, 14.7% had asthma and 14.2% had anaemia. The authors also found that more than half of the COPD population studied (52.8%) had more than one comorbidity (Mannino et al., 2015). These comorbidities not only increased the cost of care for people living with COPD (Mannino et al., 2015) but also increased the annual hospitalisation rate, increased the length of hospital stay, and increased the in-hospital mortality rate (Baty et al., 2013), thus being a significant burden to the health care system and society.

The 2013 National Health Committee Strategic Overview of Respiratory Disease in New Zealand revealed a similar pattern in New Zealand to that seen in the international data: a high economic cost to treat people living with COPD in New Zealand because of their higher hospital admission rates, longer hospital stay, and higher mortality rate (New Zealand Ministry of Health, 2013). The prevalence rate for New Zealand adults, 45 years of age and above, who were living with COPD was 6.6%. This percentage was equated to 96,100 adults

or 1 in 15 individuals over 45 years of age. The survey may have uncovered a small portion of the true COPD population mainly due to the under-diagnosing of the illness. Another New Zealand study by Shirtcliffe et al. (2007) found an age-adjusted prevalence rate of 14.2% for adults aged over 40 years of age. The underestimation was attributed to under-diagnosing of the COPD condition due to lack of understanding and diagnosing tools (spirometer) among GPs. It is also worth noting that COPD normally would present itself later in life; it is an age related disease. If we apply the above percentage values to the Canterbury region, in New Zealand, we can appreciate the significance of the issue and its burden to the healthcare system. According to the 2013 Census (Statistics New Zealand, 2013) there were 539,436 people were living in the Canterbury region, 47.4% were above the age of 40 (47.5% male, 52.5% female). These values would suggest a prevalence estimate of 16,876 to 76,600 people living with COPD in the Canterbury region. The 2013 National Health Committee Strategic Overview of Respiratory Disease in New Zealand also revealed the Māori population had twice the prevalence in COPD compared to people of other ethnic groups. It also reported women living in the more deprived regions were more likely to have COPD than their counterparts living in more affluent areas. Chronic obstructive pulmonary disease accounted for 1,523 deaths in 2006, 39% of the total respiratory deaths.

The high cost of looking after people living with COPD is also worth noting. The 2006-2009 ethnic-standardised hospitalisation rates indicated women and Māori had higher hospital admission rates. A Health Needs Assessment for the Central Region's District Health Boards report (2008) cited COPD as accounting for 95% of avoidable respiratory death. From an OECD health report (2011), New Zealand has the second highest COPD admission rate, second only to Ireland. The cost of providing treatments to the COPD patients in New Zealand was estimated to be NZD 102 million to NZD 192 million per annum (Town, Taylor, Garrett & Patterson, 2003). The average cost of care per patient per year was estimated to be NZD 2,566 (compared to NZD 2,500 for asthma), this amount did not take into consideration

other financial costs from loss of income, the costs to family, or loss of quality of life.

Chronic obstructive pulmonary disease patients had a longer hospital stay as well, with an average of 4.2 days (compared to 1.3 days for asthma), costing a grand total of NZD 54 million in hospitalisation (20.3% of total respiratory hospitalisation cost).

Pulmonary Rehabilitation

The pulmonary rehabilitation programme is an evidence-based health intervention (Ries et al., 2007). It has been shown to reduce the risk of hospital admissions and mortality in people living with COPD (Puhan, Scharplatz, Trooters, & Steurer, 2005). The pulmonary rehabilitation programme has demonstrated that it can decrease the participants' dyspnoea, fatigue levels, and give a sense of control over their respiratory conditions (Lacasse, Maltais, & Goldstein, 2004). McCarthy et al., (2015) in their Cochrane review on the effects of pulmonary rehabilitation on people living with COPD concluded that, due to strong evidence, no further RCTs are warranted to test the positive effects of pulmonary rehabilitation. In their review of 65 RCTs involving 3,822 participants they reported a statistically significant improvement for all functional and exercise capacity outcomes in the participants of pulmonary rehabilitation. Respiratory physicians in Canterbury have described pulmonary rehabilitation to be "at least as effective as inhaled medications" (Canterbury HealthPathways, 2016).

The American Thoracic Society (ATS) and the European Respiratory Society (ERS) have jointly defined pulmonary rehabilitation, which the Canterbury Community Pulmonary Rehabilitation Team has accepted as:

a comprehensive intervention based on a thorough patient assessment followed by patient-tailored therapies that include, but are not limited to, exercise training, education and behaviour change, designed to improve the physical and psychological condition of people with chronic respiratory disease and to promote the long-term adherence to health enhancing behaviours (Spruit et al., 2013).

Puhan et al. (2005) conducted a systematic review of RCTs on the benefits of pulmonary rehabilitation for COPD patients. The authors focused on finding trials relating to patients attending the pulmonary rehabilitation programme after an acute exacerbation episode. In the review, Puhan et al. (2005) identified six trials with a total of 230 patients. The authors reported a relative risk ratio for unplanned hospital admission of 0.26, favouring the pulmonary rehabilitation approach instead of the usual care approach when treating patients living with COPD. In other words, for every 100 COPD patients only 26 COPD patients who had pulmonary rehabilitation had an unplanned hospital admission. The review also reiterated the positive influences on quality of life that pulmonary rehabilitation is able to bring about for the COPD population. The majority of pulmonary rehabilitation programmes use the CRQ or the St George Respiratory Questionnaire (SGRQ) to measure patient self-reported quality of life in the fatigue, emotional function, mastery, and dyspnoea domains. This systematic review reported that there was a consistent effect favouring the pulmonary rehabilitation approach when the primary outcome measure was the quality of life of the COPD patients. Puhan et al. (2005) used exercise tolerance as an outcome measure and reported that all the reviewed journals indicated the favourable effect of pulmonary rehabilitation on the six-minute walking test (SMWT) in COPD participants. The reported mean difference outcome in the reviewed articles exceeded the minimal clinical significance difference value of 53 metres which was set by the authors. The minimal clinically important significant difference is different from the statistical significant value. A statistically significant change is where a p -value is used to determine the level of statistical significance. The minimal clinical important difference is defined as the smallest difference measurable by a validated assessment tool which indicates a meaningful clinical change in the condition, for better or worse. This perception of change can be reported by the patient, clinician or investigator involved (Spruit et al., 2013) and is used in clinical practice where meaningful clinical change is the primary outcome of interest.

In the Puhan et al. (2005) review, pulmonary rehabilitation was shown to improve the survival of people living with COPD. The relative risk ratio for mortality was 0.45 for pulmonary rehabilitation participants, which indicates that for every 100 COPD patients 55 would have an improved survival rate by attending pulmonary rehabilitation. The pulmonary rehabilitation participants had longer survival days if they were admitted to a respiratory intensive care unit compared to the patients who had no exposure to the pulmonary rehabilitation. The authors indicated, provided the participants started their own individual walking training, pulmonary rehabilitation was able to improve the mortality rate.

Pulmonary rehabilitation is not only effective but also one of the most economical ways of managing people living with COPD. From the literature search, I found the savings from pulmonary rehabilitation varied greatly. Golmohammadi, Jacobs and Sin (2004) undertook an economic evaluation of their community-based pulmonary rehabilitation programme in Canada. They reported at one year after participants attended the pulmonary rehabilitation programme there was an improvement in self-perceived health, associated with decreased health care utilisation and reduced direct health costs. There was a total saving of CAD34,367 per 100 person-years or about CAD344 (NZD 406) per person per year. A more recent study by Chakravorty, Fasakin, Paine, Narasimhaiah, and Austin (2008) also looked into the direct cost-saving that pulmonary rehabilitation programmes can achieve in the United Kingdom. They concluded that the pulmonary rehabilitation programme was economical mainly due to its ability to reduce inpatient hospital stays for people living with COPD (2.35 days) and in primary health utilisation. A total of GBP1,835 (NZD 4,207) was saved from the health system per person in the 12 months post pulmonary rehabilitation.

Internationally, the current pulmonary rehabilitation evidence supports that exercise training and facilitating behavioural changes in the self-management in people living with COPD are effective, however, a consensus on the ideal pulmonary rehabilitation programme structure, duration and staff-to-patient ratios is still to be reached (Spruit et al., 2013; Bolton et al.,

2013; Spruit et al., 2013). In the McCarthy et al. (2015) Cochrane systematic review, the authors identified similar issues concluding that there was a wide range of methods and models used in different countries to delivering pulmonary rehabilitation. It is, therefore, difficult to describe the optimal pulmonary rehabilitation programme structure due to the heterogeneous nature of the programme delivery and outcomes (McCarthy et al., 2015; Spruit et al., 2013; Bolton et al., 2013). Bolton et al., (2013), when they developed the latest pulmonary rehabilitation guidelines for the British Thoracic Society (BTS), recommended that pulmonary rehabilitation programme duration should be 6-12 weeks and that it should be offered to people living with COPD with a view to improving exercise capacity, dyspnoea, health status, and psychological wellbeing by a clinically important amount. The authors' recommendations were based on Grade A evidence, which was defined as having at least one high quality meta-analysis, systematic review, or RCT and directly applicable to the target population with an overall consistency in the results demonstrated (Bolton et al., 2013). Spruit et al. (2013), when developing the ATS/ ERS guideline on pulmonary rehabilitation, had identified the lack of clarity in the international literature on the best format for delivering pulmonary rehabilitation. However, based on the current available evidence and expert opinion, the guideline recommended the pulmonary rehabilitation programme should be at a minimum of eight-weeks long for the participants to experience some clinical improvement. A literature search on the optimal number of sessions per week and the staff-to-patient ratios remains inconclusive (Spruit et al., 2013).

Based on the current evidence, both the BTS and ATS/ERS guidelines were unable to establish the optimal structure and format in delivering pulmonary rehabilitation. both guidelines did agree on three aspects: 1) pulmonary rehabilitation is clinically effective in improving the symptoms and the health status of the people living with COPD, 2) exercise training is clinically effective in improving the prognosis and wellbeing of the people living with COPD, and lastly 3) behavioural change and collaborative self-management through

education and information sharing (a component of pulmonary rehabilitation) can reduce health care use.

Research hypotheses

1. The CRQ results will demonstrate the home-based pulmonary rehabilitation performs no worse (no statistically significant difference) than the traditional centre-based pulmonary rehabilitation in all four domains (dyspnoea, fatigue, emotional function and mastery) of the questionnaire.
2. The 1MSTST, the standardised exercise capacity test in the Canterbury centre-based pulmonary rehabilitation, will demonstrate a significant improvement in the home-based pulmonary rehabilitation.

Research objectives

There were two stated investigation objectives to this research project. First, this research aimed to establish the clinical effect and performance of the home-based pulmonary rehabilitation through the CRQ. The CRQ is a validated, respiratory, and disease-specific quality of life questionnaire. Second, this research would be able to demonstrate an objective change in the 1-minute sit-to-stand test, a quick exercise testing tool. This thesis would then be able to make some recommendations to the future service providers of the home-based pulmonary rehabilitation by exploring the above three objectives.

In Summary

The majority of the participants on the PR programmes are living with COPD, a progressive illness that causes shortness of breath on minimal exertion, an increase in sputum production and eventually premature ageing and death. The illness causes significant loss of productivity and management cost to the health system. Pulmonary rehabilitation is one form of effective and evidence-based treatment to people living with a chronic respiratory condition. In Canterbury, the programme has been described by the respiratory physicians to be at least as effective as the medications that are inhaled (Canterbury HealthPathways, 2016). The

pulmonary rehabilitation programme is known to improve the health status, prognosis, and wellbeing for people living with COPD through knowledge, exercising, and a reduction in isolation.

There are four main foci to this thesis project. 1) To investigate an alternative way of delivering pulmonary rehabilitation for people like Jason. 2) To validate the effect of the chosen alternative pulmonary rehabilitation option and lastly, 3) to make recommendations to the pulmonary rehabilitation provider from the project findings.

Chapter 2: Literature Review

Introduction and guide to the reader

As mentioned previously, internationally, the physiological mechanisms underpinning COPD and the effects of pulmonary rehabilitation on managing people living with COPD have been studied extensively and supported. In practice, however, the low uptake of pulmonary rehabilitation programmes continues to be a central issue, because many COPD patients who could benefit from participation in a pulmonary rehabilitation programme are not taking part. In the case scenario provided earlier, Jason was unable to attend a pulmonary rehabilitation programme due to his work commitments and the significant amount of travelling that would be involved if he were to attend a pulmonary rehabilitation programme at a city venue – a two-hour round trip by car. This review examines the literature, both locally and international, to investigate the issues and reasons for the low attendance at centre-based pulmonary rehabilitation programmes. The literature review also explores the evidence on alternative pulmonary rehabilitation delivery options, namely the home-based programme. If a home-based programme is found to be effective, this delivery option would offer people like Jason a new opportunity to learn more about, and improve, his breathing condition. The review also presents the evidence for the objective measures used in this research project. In brief, there are two main questions that frame the literature review:

1. What are the current research findings about low attendance to the pulmonary rehabilitation programmes?
2. What current evidence informs home-based pulmonary rehabilitation programmes?

Electronic databases, Google Scholar and PubMed, were searched from the time this thesis project was conceptualised to April 2016. To be included, the articles needed to specify that participants were living with a confirmed diagnosis of a chronic respiratory condition; the participants must be older than 18 years of age; the articles must be written in English or have been translated to English and lastly, the keywords used in the search must have been mentioned either in the title or the abstract of the article. The articles were excluded if

participants had not been diagnosed with a chronic respiratory condition or if they had attended programmes other than the pulmonary rehabilitation. The main search keywords used for identifying low pulmonary rehabilitation attendance were: “COPD”, “pulmonary rehabilitation”, “adherence”, “compliance”, “attendance”, “attendance”, “analysis” and “review”. Two local and three international articles were identified as relevant from the initial 80 search results. Key words used in the search for the evidence on the home-based pulmonary rehabilitation were “home-based”, “home based”, “home-based pulmonary rehabilitation”, “COPD”, “review” and “analysis”. A total of 12 studies were identified, from the initial 85 search results, and interestingly the search did not produce any local home-based pulmonary rehabilitation studies. Lastly, evidence behind each of the routine pulmonary rehabilitation objective measures were explored and explained.

[Pulmonary Rehabilitation in Canterbury](#)

The first Canterbury pulmonary rehabilitation programme was run in the late 1980s as a joint venture between the Physiotherapy Department and Cardio-Respiratory Outreach Services, Christchurch Hospital. After it was established, and for the next 20 years, pulmonary rehabilitation programmes were run centrally at one venue, the Christchurch Horticultural Hall. Since the establishment of the Community Respiratory Services (CRS) the pulmonary rehabilitation service has continued to evolve to meet patient needs. The community pulmonary rehabilitation team is now supporting nine pulmonary rehabilitation programmes in eight different venues across Canterbury (Amberley, Rangiora, City North, City East, Central East, Central South, City West, and Ashburton) (HealthInfo,). The clinical reasoning behind the different venues was to improve patient access to this effective intervention for people living with chronic breathing illnesses with the intention that this would translate to better adherence and attendance to the pulmonary rehabilitation programme.

In Canterbury, the pulmonary rehabilitation programme is eight-weeks long, two sessions per week, and two hours per session. The two hours consist of one hour of exercise and one hour of education. The exercise component of the programme is delivered by setting up a gym circuit with some simple gym equipment, such as Thera-Bands, weights, seated bikes, steps, stairs, and exercises involving a chair, a wall and a table (see Figure 1).

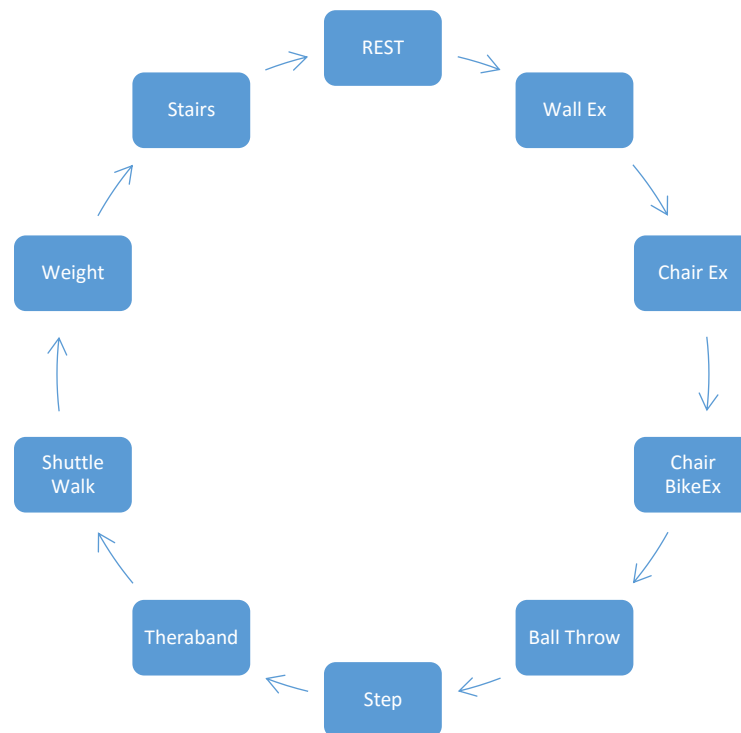


Figure 1. Exercise circuit for a pulmonary rehabilitation programme.

The time spent on each exercise station starts at three minutes and gradually increases to five minutes per station towards the end of the programme. The gradual increase in time reflects the fitness improvement gained over the course of the programme. The education component of the pulmonary rehabilitation programme involves presentations and dynamic discussions from the specialist speakers to the pulmonary rehabilitation participants (see Figure 2).

(Venue) PR Education Planner (code)						
Week	Session	Day	Date	Hours	Education Session	Specialty
1	1				Intro Part One	Physiotherapist
	2				Mihi whakataua Intro Part Two and Goal Setting	Clinical Psychologist
2	3				What is COPD? How is it treated?	Community Resp. Physician
	4				Inhalation devices and techniques	Respiratory Nurse
3	5				Living smoke free	Respiratory Nurse
	6				Eating Well	Dietician
4	7				Medications	Pharmacist
	8				How to live with chronic airways/lung disease	Social Worker
5	9				Stress and Relaxation Techniques	Physiotherapist
	10				Osteoporosis / Falls prevention	Physiotherapist
6	11				Breathing not Busting	Physiotherapist
	12				Energy conservation	Occupational Therapist
7	13				COPD Self Management/How to talk to your Doctor	Respiratory Nurse
	14				Loving Relationships / Sleep Services	Sleep Service
8	15				Maintaining the Focus and Sustaining the Gains	Clinical Psychologist
	16				Community Links, Green Prescription, Q&A	Resp Relief

Figure 2. Education sessions for a Canterbury pulmonary rehabilitation programme.

The specialist speakers include a respiratory physician, clinical psychologist, physiotherapist, nurse specialist/educator, dietician, pharmacist, social worker, occupational therapist, and community exercise group representatives (Green Prescription, Respiratory Relief Society, and the like). The aim of the education sessions is to empower the pulmonary rehabilitation participants with more knowledge about their breathing conditions and strategies to enable the pulmonary rehabilitation participants to live more positively.

In Canterbury, “Health Pathways” (Canterbury HealthPathways:

<http://www.healthpathways.org.nz/>, accessed 2014) provide detailed guidelines to GPs on the management of people living with COPD in the community. The ideal management pathway for those over 40 would be to first, make a confirmed diagnosis of COPD by arranging a spirometry for people who are breathless, and then take a smoking history. Second, if they are still a smoker, those living with COPD should be advised of smoking cessation strategies, and referred to a pulmonary rehabilitation programme. Influenza immunisation, a COPD action

plan and dietary support are also important. GPs can make referrals to other allied health professionals, for example, to a respiratory physiotherapist, if the patient is struggling with clearing his/her phlegm. GPs are also advised to refer the patient to a respiratory physician for a consultation if the case is complex. Overall, in Canterbury, there is a comprehensive integrated respiratory service structure for people living with COPD, ranging from the community health care professionals (GP, practice nurse visits), to the integrated respiratory services (pulmonary rehabilitation, breathing test, and sleep study), to tertiary care services (specialist consult) for the more complex cases.

Unfortunately the movement of the pulmonary rehabilitation programmes to patients' neighbourhoods made limited improvement to attendance and adherence numbers. According to the Canterbury Clinical Network (<http://ccn.health.nz/>, data accessed 30th February 2016) in the period January 2014 to January 2015, the pulmonary rehabilitation team had received a total of 506 referrals from the pulmonary rehabilitation database. Despite the ability to offer patients the choice of attending a pulmonary rehabilitation programme close to home, on the first telephone contact, 299 patients (close to 60%) declined the offer to attend a programme. Altogether, 207 patients agreed to participate in the programme a further 62 patients (30%) withdrew or did not complete the programme (i.e. attended fewer than eight out of 16 sessions) for various reasons. In other words, from the time of receiving the appropriate referrals, just over 70% of the patients dropped out of the programme. These values are consistent with Australian counterparts. Keating and Holland (2011) found 8 to 50% of referred patients never made it to a pulmonary rehabilitation programme and 10 to 32% of the patients who started a programme did not complete it. Knowing the severity of the issue, it was proposed and agreed by the Pulmonary Rehabilitation Working Group in July 2014 to pilot an alternate form of pulmonary rehabilitation: a home-based pulmonary rehabilitation programme to tackle the low completion rate. This home-based pulmonary rehabilitation programme is the focus of this thesis.

Low attendance in Pulmonary Rehabilitation programmes- New Zealand literature:

Levack, et al. (2012), is the only known academic paper on the New Zealand context that examined the uptake of pulmonary rehabilitation in New Zealand in 2009. The results showed less than 1% of the New Zealand COPD population were referred to a pulmonary rehabilitation programme. The authors sent out surveys by post to all identified pulmonary rehabilitation providers in New Zealand and requested information on the characteristics of the pulmonary rehabilitation programmes and the estimated numbers who had been offered pulmonary rehabilitation, entered and completed a pulmonary rehabilitation programme. The response rate to the survey was high (91%). Twenty-one out of the 23 identified pulmonary rehabilitation providers, 16 from the District Health Boards (DHB), five from the Primary Health Organisations (PHO), one from a DHB/PHO partnership and one from Non-Government Organisation (NGO), responded. The survey results showed a total of 2,569 people living with COPD were offered pulmonary rehabilitation; 1,786 entered a pulmonary rehabilitation programme and 1,378 had completed a pulmonary rehabilitation programme in 2009. Shornccliffe et al. (2007) estimate 14.2% of adults over the age of 40 have COPD, and therefore it was calculated that in 2009, New Zealand was likely to have 213,400 to 329,800 people living with COPD. The results showed a conservative estimate of only 0.9% of the COPD population in New Zealand had been referred to a pulmonary rehabilitation programme. Although the estimated value appeared discouraging, it was in line with similar survey findings undertaken in the United Kingdom and Canada (Brooks et al., 2007; Yohannes & Connolly, 2004). Levack et al. (2012) speculated that the main causes of the low uptake rate in New Zealand maybe due to “the lack of direction and lack of financial incentives offered at the public policy level”. Levack and colleagues (2012) explained further by stating the undeniable importance of smoking cessation as the best treatment for people living with COPD, but the need for pulmonary rehabilitation will continue to exist for at least 20 to 30 years after New Zealand meets the ‘Smokefree’ status in 2025. Therefore, it is important for the respiratory service in the national, regional and local levels to have strong

leaders to continue to drive this effective intervention for people living with COPD (Levack et al., 2012).

Many studies locally and internationally have investigated reasons for the low participation rate in this effective treatment for people living with COPD (Ramage et al., 2016; Keating, Lee & Holland, 2011; Harris, Hayter & Allender, 2008; Fischer et al., 2009). Ramage et al. (2016) explored the factors associated with non-attendance to the community pulmonary rehabilitation in the Canterbury region. The project was a mixed method cohort study of patients referred to the Canterbury community pulmonary rehabilitation. A series of standardised quantitative and qualitative interview questions were developed using the HADS and some adaptations from the Subjective Health Complaints (SHC) inventory. There were a total of 154 eligible participants, 75 participants completed the interview (48.7%), 70 could not be contacted, and 9 did not wish to participate in the study. The mean age for the completed group was 68.5 years and 64.2 years for the could-not-be-contacted group. The gender and ethnicity distributions were similar in both groups. Inductive thematic analysis was carried out to investigate trends and themes in the interview transcripts. The analysis identified five main themes for not attending a pulmonary rehabilitation: conflict with everyday life, travel, fears and anxiety, belief and understanding about pulmonary rehabilitation, and a lack of perceived pulmonary rehabilitation benefits. Based on these qualitative and quantitative findings Ramage et al. (2016) made some recommendations to the pulmonary rehabilitation services on ways to tackle the low pulmonary rehabilitation attendance. The authors recommended that information sharing with the referring clinicians and the patients should be reviewed and made easier for people who access it. The information sharing pathways such as the Canterbury HealthPathways (as mentioned previously a GP tool), pulmonary rehabilitation referral form and pulmonary rehabilitation information pamphlet should be updated with relevant and user friendly information. Other recommendations from the report included rebranding of pulmonary rehabilitation to a more

meaningful name to the users and establishing an alternative method of delivering pulmonary rehabilitation to capture the younger working users who missed out on the current pulmonary rehabilitation services, such as online delivery, evening after-work programme, and a home programme.

[Low attendance in Pulmonary Rehabilitation programmes- International Literature](#)

Overseas, the study by Keating, Lee, and Holland (2011) identified a few stand-out factors for the low attendance to the pulmonary rehabilitation programmes in their systematic review of the literature. A total of 796 articles were identified in the initial database search. After removing duplicates and filtering of the inclusion and exclusion criteria, 11 articles remained. To be included in the review, the subjects needed to have a confirmed diagnosis of COPD, have participants 18 years or over, be written in English, and have factors associated with non-attendance or non-completion of PR as part of the discussion. The exclusion criteria for the articles were if the subjects were not diagnosed with COPD and were attending a programme other than a pulmonary rehabilitation one. In the eleven articles selected, the demographic characteristics of the participants showed a wide spectrum range. The disease severity ranged from mild to very severe COPD. The mean age of the population ranged from 61 to 75 years of age and the majority of the studies had more men than woman as the listed participants. From the qualitative studies, the authors found a lack of perceived health benefit from attending pulmonary rehabilitation, patient's perception of using exercise as a treatment to their breathing condition, difficulty accessing a pulmonary rehabilitation programme either due to poor personal mobility, lack of transport or cost of transport, and being unwell either due to the direct impact of COPD or other comorbidities during the course. Other minor factors included the time commitment to the programme, older age, fatigue, and lack of social or family support. The authors concluded that more effort was required in disseminating the proven benefits of pulmonary rehabilitation to the eligible patients and, at the same time,

more effort should be made to explore the different models of delivery to meet the needs of the patients. (Keating et al., 2011).

Another qualitative study, by Harris, Hayter, and Allender (2008), echoed the findings of Keating et al. (2011); however, Harris et al. (2008) looked at the non-attendance reasons from the perspective of the fear of the patients in attending a pulmonary rehabilitation programme. The authors contacted 110 patients from a suburban general practice in north-east Derbyshire, United Kingdom, from which 16 patients with confirmed COPD diagnosis agreed to participate in the interview. The 16 participants consisted of males (12 out of 16), ex-smokers (14 out of 16) and had an average age of 66.8 years. Nine participants had mild COPD, five had moderate, and two had severe COPD. The interviewer asked six standardised topic questions which were themed around the participant's experience of living with COPD and the participant's perception of pulmonary rehabilitation. The responses were analysed using open inductive coding through line-by-line reading of the interview transcript using the principles of grounded theory. The results revealed patients' fear of exercise and being breathless as the key themes related to pulmonary rehabilitation perception. The patients also mentioned the fear of pulmonary rehabilitation having a non-favourable effects on their other coexisting medical conditions. The authors explored other possible solutions to the fear of participating in a pulmonary rehabilitation programme through the structured interview session. They identified some motivators that may help to reduce the fear factor. Motivators such as pulmonary rehabilitation has the potential to reduce the sensation of breathlessness, regaining control over life, and regaining ability to do things the patient enjoys. Harris, Hayter and Allender (2008), in their conclusion, suggested the importance of acknowledging the patient's fear and the need to create a positive attitude to facilitate the participant in understanding the potential health benefits pulmonary rehabilitation programme can deliver.

Lastly, Fischer et al. (2009), in their qualitative semi-structured interview study, looked at the participation and drop-outs of pulmonary rehabilitation programmes from another interesting

angle. Four women and eight men living with COPD from two rehabilitation centres in the Netherlands were recruited to this study. The average age for the study population was 61 years of age. Of the 12 participants, two were still actively working, six had to stop working due to their illness and four had retired. The authors found that there is a “continuous trade-off between the subjective need for improvement (the anticipated attainable benefits) on the one hand and concerns and barriers to attending pulmonary rehabilitation classes on the other” (Fischer et al., 2009). The study reported from an interpretative phenomenological analysis, the COPD patients’ perception or beliefs about their medical condition and also about the management of their illness through PR, and the way that it appeared to play a critical role in determining the uptake or drop-out from pulmonary rehabilitation programmes. The patients also reported on the intensity of the pulmonary rehabilitation, lack of visible improvement or not achieving the anticipated improvement prior to attending the pulmonary rehabilitation, and other social problems could push the participants towards dropping-out from the pulmonary rehabilitation programme.

Home-based pulmonary rehabilitation

Home-based pulmonary rehabilitation had been speculated as an appropriate alternative to the standard centre-based pulmonary rehabilitation for all COPD patients of differing severities (Fernández et al., 2009; Boxall et al., 2005; McFarland et al., 2012; Strijbos et al., 1996). In recent years, more studies have looked into the effects of the self-monitored home-based pulmonary rehabilitation (Maltais et al., 2008; de Oliveira et al., 2010; Jolly et al., 2007; Ghanem et al., 2010; Hernadez et al., 2000; Khoshkesht et al., 2015; Burkow et al., 2015; Majewski et al., 2015).

Majewski et al. (2015) demonstrated the effects of a home-based pulmonary rehabilitation programme for older females living with bronchial asthma. The clinical trial involved 10 participants who had completed the programme, with a mean age of 70.8 years and body mass index of 24.6. The participants were students at the University of the Third Age in

Wroclae, Poland, and all of them were living with diagnosed mild to moderate bronchial asthma. The authors used the SGRQ to evaluate the health-related quality of life of the participants. The Fullerton Functional Fitness test and the six-minute walking test were the main exercise capacity objective measures. Other objective tests used were the modified Borg scale, the Medical Research Council scale for breathlessness level, spirometric values, and the HADS for mental status. The programme ran for eight weeks with two home exercise sessions and one supervised exercise session per week. On completion of the eight-week programme, the authors found significant improvement to the participants' breathing muscles and spirometric readings. Their results also suggested significant improvement in the exercise capacity of the participants, with a statistically significant improvement in the lower body flexibility trial and six-minute walking test distance (mean change of 36 metres, $p < 0.05$).

Maltais et al. (2008) conducted a multicentre, randomised and non-inferiority trial to examine the effects of the home-based pulmonary rehabilitation in patients with COPD. Two hundred and fifty-two patients participated in this study across 10 different academic and community medical centres in Canada. All the participants were invited to attend standardised education and self-management sessions over a four-week period. The patients were then randomly assigned to either a home-based programme or to an outpatient hospital-based rehabilitation programme for 8 weeks. Once the participants completed the 12-week programme they were followed up for 40 weeks to map out their one year trend. Their primary outcome measure was the CRQ. The results at the one year mark showed a similar improvement between the home-based and the centre-based programmes and the difference between the two intervention groups was "small and clinically unimportant" (Maltais et al., 2008). The authors concluded that the home-based pulmonary rehabilitation was no worse than, if not equal to, the effects of a hospital centre-based pulmonary rehabilitation in the COPD population.

In Brazil, de Oliveira et al. (2010) did a randomised controlled prospective study with 117 COPD patients, comparing the effects of an outpatient-based pulmonary rehabilitation and a

home-based pulmonary rehabilitation. The patients were recruited from a private pulmonology clinic and randomly allocated to one of three different groups: home-based pulmonary rehabilitation, outpatient pulmonary rehabilitation and a control group. The home-based pulmonary rehabilitation group patients were informed to perform all pulmonary rehabilitation activities unsupervised at home. The outpatient pulmonary rehabilitation group participants performed all the pulmonary rehabilitation activities in a clinical setting, supervised by a physiotherapist. The control group participants did not perform any pulmonary rehabilitation activities. The patients consisted mainly men in all three groups with a mean age of 66.4 years for the home-based, 71.3 years for the outpatient group and 70.8 years for the control group. All patients received a one-off education session on the initial evaluation day. The education session covered the topics regarding the development and progression of COPD, all available treatments for COPD, oxygen therapy, and the importance of an exercised-based rehabilitation. The programme ran for 12 weeks. The primary outcome measures for this study were six-minute walk distance and Body-mass index, Obstruction, Dyspnoea, and Exercise index (BODE), which is a multidimensional scoring system in predicting the survival rate of a COPD patient. The results of the trial showed that both home-based and hospital-based programmes produced statistically significant improvements to the patients' six-minute walking distances and also the BODE index scores. The authors of this study also suggested that the home-based self-monitored pulmonary rehabilitation is an effective alternative to the standard centred-based pulmonary rehabilitation.

Ghanem et al. (2010) undertook a randomised clinical trial in Egypt where they recruited a total of 39 participants living with COPD after they were discharged from an acute admission to the local hospital. The participants were randomly allocated to two different groups: the home-based pulmonary rehabilitation group (25) and the control group (14). The home-based group participants were assessed and educated prior to their discharge from the hospital and

the control group participants did not receive any pulmonary rehabilitation education and were cared for according to the local usual medical care for people living with COPD. Those in the home-based programme were monitored and reviewed after two months. The main outcome measures used in this clinical trial were the six-minute walking distance, CRQ, and quality of life scale Short Form (SF-36). The mean ages for the two groups were 56.96 years for the home-based group and 56.43 years for the control group. The article did not specify the gender distribution. Most of the participants had moderately severe COPD. At the final end-of-programme assessment, the home-based pulmonary rehabilitation showed a statistically significant improvement in the six-minute walking distance and in both quality of life questionnaires when compared to the control group. The authors found at the two-month period, that the home-based pulmonary rehabilitation was an effective way of managing people living with COPD after an acute hospital admission,

Burkow et al. (2015) conducted a mixed-pilot study on ten people mostly living with severe to very severe COPD, from the county of Troms, northern Norway. This nine-week long home-based online programme was based on the outpatient pulmonary rehabilitation model run at the University of North Norway, where the participant would receive once a week online education session and two online exercise sessions per week. The main objective measure used was the SGRQ. There were five males and five females in the group with a mean age of 61.7 years (range 46-72 years). On completion of this small sample-sized study, the authors found a probable clinically significant improvement in the SGRQ total score (mean change 6.53, $p < 0.05$). Burkow et al. (2015) reported the participants found the online interface easy to use and that it was able to improve participants' social interaction through the online media platform provided. This was especially important because three of the participants in the group lived 180-220 km away from the main outpatient clinic. The authors felt that despite the small sample size, the home-based online pulmonary rehabilitation was a

feasible option for people living with COPD and the technological involvement appeared to be well accepted by the study participants.

Based on the decision of the pulmonary rehabilitation working group and also the literature review findings, a pilot study for a home-based pulmonary rehabilitation programme in Canterbury was commissioned to meet the needs for people like Jason, would benefit from pulmonary rehabilitation but unable to attend. There are two main objectives to this pilot study.

- 1 Could the alternative Home-based Pulmonary Rehabilitation Programme perform comparably to the standard Centre-based Pulmonary Rehabilitation Programme in the quality of life measure, using the Chronic Respiratory Questionnaire?
2. Could the participants in the Home-based Pulmonary Rehabilitation Programme perform at the same level as the Centre-based Pulmonary Rehabilitation Programme participants in the exercise tolerance test, using the sit-to-stand measure?

Chapter 3: Methods

The study population

The study population was recruited from people living with COPD in the community, referred by health professionals, but mainly by GPs and respiratory physicians, to the Canterbury community pulmonary rehabilitation programme (four locations: North City, East City, West City and Central City) between the years 2010 to 2014. The study population was the non-attenders and non-completers (completed less than half of the programme sessions) referred to the pulmonary rehabilitation programmes over this five-year period. As mentioned previously, prior to this project, there were no community rehabilitation services available to look after people living with chronic respiratory conditions. The Community Respiratory Services Team has been storing these *referred but unable-to-attend* people in their database and this was accessed for the purposes of this study.

Setting

The study took place in Canterbury, New Zealand. The population in Canterbury, at the 2013 Census, was close to 540,000 people. The main primary health organisation (PHO) servicing the mid and upper Canterbury area is Pegasus Health (Charitable) Limited. The Pegasus Health (Charitable) Limited PHO was established in 1992 “when a group of Christchurch general practitioners met to see how they could use the ‘health reforms’ of the time to get a better deal for the local community” (Pegasus Health website, 2016). The early Pegasus Health pioneers attracted a majority of the Christchurch based GPs and formed an Independent Practitioner Association (IPA) with a strong focus on the clinical education and reducing health funding wastage (Pegasus Health website, 2016). Currently, Pegasus Health PHO provides its services to about 80% of the general medical centres in the region with a combined doctor and nurse membership of about 300 members. Pegasus Health is also closely associated with pharmacy services in the region, providing clinical guidance and professional education opportunities. In the mid-Canterbury region (Ashburton to Kaikoura) there is a single-point of entry for referrals to the community pulmonary rehabilitation

service. General practice doctors play an essential role in the management of community dwelling respiratory patients, because they are the gatekeepers to the health and wellbeing of people living with chronic illness. People just like Jason, mentioned in the first chapter, a semi-retired farmer living with COPD, and would present themselves to their general practices with breathlessness issues. Once the doctor established that the breathlessness was due to a chronic respiratory condition through a series of spirometry results, and diagnose COPD, the doctor would explain all the available treatment options, including the pulmonary rehabilitation programme. Once the patient felt they were informed enough and agreed to a pulmonary rehabilitation referral, the doctor sends a referral by fax or through the electronic referral management system (ERMS) to the administrator of the Community Respiratory Services Team (CRST). The CRST is a team of 11 (an operations manager, two part-time respiratory physicians, two administrators, five respiratory nurses and a respiratory physiotherapist) who are tasked with encouraging and facilitating the integration of respiratory services in the Canterbury region, with a vision of creating a balanced and sustainable respiratory service to look after the wellbeing of all respiratory patients (<http://www.ccnweb.org.nz/Activities/LongTermConditions/IntegratedRespiratoryService.aspx>, accessed in April 2016).

All information and communication activities are stored electronically in the CRST MEDtech 32 patient management system, which is a communication and patient management system used by the majority of the GPs in the Canterbury region. On the basis of Jason's preference or home location, he is then allocated to the most convenient community pulmonary rehabilitation programme.

The community pulmonary rehabilitation locations are well distributed across the mid-Canterbury region. The boundaries of the community pulmonary rehabilitation coverage are: Amberley to the north, Templeton to the west, New Brighton to the east and Ashburton to the south (Figure 3). The venue options available from north to south are Amberley, Rangiora,

Christchurch North, Christchurch East, Central East, Central South, Christchurch West and Ashburton. From 2010 to 2014 the CRST delivered on average nine community pulmonary rehabilitation programmes per year, with a strong focus on the eastern suburbs of Christchurch because it was, and still is, deemed a high need area for community respiratory support due to its predominantly lower socioeconomic based community background.



Figure 3. The yellow spots indicate the boundary of the Canterbury community pulmonary rehabilitation programmes.

As discussed in the literature review, the uptake of community pulmonary rehabilitation is an ongoing challenge to the service. On average, half of the referred patients decline the community pulmonary rehabilitation services on first contact. Of the remaining half of the referred patients, who agreed to participate in the community pulmonary rehabilitation service on first contact 30 to 50% of them will drop out from the course. In the calendar year

January 2014 to December 2014 there was a total of 506 referrals, 206 (40% of the total referrals) patients attended one or more sessions. In other words, 60% of the people referred to the community pulmonary rehabilitation programme did not want to attend or were unable-to-attend a community pulmonary rehabilitation programme. Overall, 145 (70% of all attendance) completed more than half of the total 16 sessions (Report from CRST pulmonary rehabilitation data from Medtech, 2014). The Canterbury Pulmonary Rehabilitation Working Group (CPRWG) was keen to trial different formats and models of delivering the community pulmonary rehabilitation to improve attendance and completion rates. The home-based community pulmonary rehabilitation was proposed as an alternate format of service delivery in the August 2013 CPRWG meeting. A literature review I conducted on the effects of the home-based community pulmonary rehabilitation and presented to a subsequent CPRWG meeting. The CPRWG was keen to pilot a study on the home-based community pulmonary rehabilitation in Canterbury but the finer details took a few more months to develop. It was eventually finalised in the September 2014 CPRWG meeting and given clinical approval to proceed. This thesis investigates this new approach to providing pulmonary rehabilitation.

Ethics committee approval

An application to undertake the proposed intervention with the study group was submitted to and approved by the University of Canterbury Human Ethics Committee, ref: HEC 2014/69 as a Master's thesis research project (See Appendix B).

After the initial submission of the human ethics application, the committee raised a few questions in regard to this research project. The questions could be summarised in two main categories: confidentiality and safety.

Confidentiality is paramount in any clinical practice. The HEC rightfully raised questions in regards to how I would manage and store the patient data collected. The data collected in this research project was securely stored in the Canterbury Clinical Network MEDtech 32 database. This database could only be accessed by the members of the CRST, which

consisted of the manager, two administrators and eight respiratory clinicians. In my role as the Respiratory Physiotherapist I already had role-based access to this data for the purposes of my work, so this would be an additional role-based access for the purposes of research reported in this thesis. This communication and data storage software records patients' outcome measures and clinically significant conversations between the patients and clinicians. All data are stored for 15 years after completion of the programme for audit purposes.

The HEC also raised questions about how patient and visiting clinician's safety would be ensured. In this research, the recruitment, pre-programme assessment, education, intervention and post-programme assessment stages strictly followed the ATS and ERS Pulmonary Rehabilitation Guidelines (Rochester et al., 2015; Nici et al., 2006) and participants are remotely monitored by experienced community pulmonary rehabilitation clinicians regularly. The research intervention would mimic the current community pulmonary rehabilitation approach. The main difference would be that in this research the interventions would be carried out at patient's home or the community pulmonary rehabilitation the interventions would be delivered in a community facility in a group setting. The visiting clinician always carries a mobile phone when in a patient's home and is competent in first aid in cases of any medical emergency. The visiting clinician clearly documents the time of visit and where about they would be on their electronic diary, which other team members can access readily.

On 30th July 2014, reference: HEC 2014/69 I had satisfied the HEC and granted approval. A copy of the HEC approval letter is presented in Appendix A.

Study Design:

This thesis study is a ten-week prospective interventional cohort study.

Recruitment

All the community pulmonary rehabilitation-referred patients who had been identified as suitable candidates were put through a *query build* on the MEDtech 32 database. The query

build is a unique filtering function in the MEDtech 32 software, which allows the user to screen and categorise the patients for analysis and report generating purposes. The eligible patients included those who, for a variety of reasons, were either unable to attend or who attended less than eight sessions of the full programme.

Sample size

A biostatistician from the University of Canterbury was approached to carry out the power analysis to determine the minimum sample size required for this research. The main objective measure for this research is the Chronic Respiratory Questionnaire (CRQ). The CRQ is an internationally validated assessment tool and frequently used for studies on people living with respiratory illnesses (Guyatt et al., 1987; Wijkstra et al., 1994; and Puhan et al., 2004).

The power calculators used were G*Power (Faul et al., 2007, 2009), developed by the University of Düsseldorf and PS power and sample size calculator (Dupont and Plummer, 1998) developed by Vanderbilt University.

The power calculator compared the difference between two independent means for the two different interventions. It was assumed the CRQ results were normally distributed. The *effect size* is the minimal clinically important change value for CRQ, as suggested by Redelmeier et al (1996) a minimum change of 0.5 is considered a small difference in symptom, 1.0 for a moderate difference and 1.5 for a large difference. Historically, the Canterbury pulmonary rehabilitation team has been stating in their communication letters to patients that a change of 2 is considered to be clinically significant. So in this case we selected 2 as the effect size, which is at the higher end of the measure used internationally. The standard deviation was calculated based on the research values suggested by the literature on CRQ-SR (Chronic Respiratory Questionnaire – Self-Reported) and they ranged from 0.7- 1.35. For the purpose of the power level calculation we have taken the median, 1. The alpha error probability was set at 0.05 as per standard practice. The power level of 0.8 was selected. The minimum

sample size the calculator gave was six, with a power level of 0.88. We increased the power level to 0.9 and the suggested sample size increased to seven.

The biostatistician explained she would never recommend any research to be done only with a sample size of seven in each group. However, in this case, because the effect size is huge (2) the sample size needed to pick up such a big change would be small. If the effect size were 0.1 then to pick up such a small change a large sample size of over 1,000 participants would have been required.

The Study Inclusion and Exclusion Criteria

In this study we delivered the home-based pulmonary rehabilitation programme to the eligible candidates. This programme followed the clinical community pulmonary rehabilitation inclusion and exclusion criteria. The study then recruited patients who *did not complete* a community pulmonary rehabilitation or *did not appear* at any sessions as study candidates. The community pulmonary rehabilitation team had defined completion as attendance at pre-assessment and post-assessment sessions plus eight or more programme sessions (out of 16). The *did not appear* group referred to patients who the service was unable to establish contact with or who were given an appointment but the patient did not show up.

In Canterbury, the inclusion and exclusion criteria for community pulmonary rehabilitation are in accordance with the American Thoracic Society and European Respiratory Society guidelines for Pulmonary Rehabilitation (2013) and British Thoracic Society guidelines for Pulmonary Rehabilitation (2013).

Inclusion criteria:

1. Diagnosed respiratory condition confirmed with spirometry, plus ongoing symptoms
2. Experiencing breathlessness in their day-to-day life
3. No cardiac event in past eight weeks
4. Any known cardiac condition (e.g. angina) must be well controlled and stable

5. On optimal respiratory medication as per Canterbury COPD Pathway (www.healthpathways.org.nz).
6. Motivated to attend. Discuss the programme with patient and confirm motivation on the referral form

Exclusion criteria:

1. Unstable angina
2. Decompensated heart failure
3. Severe hypertension (systolic > 200 and/or diastolic > 120 mmHg)
4. Uncontrolled cardiac arrhythmias
5. Severe aortic valve stenosis
6. Severe arthritis
7. Any medical problems which severely restrict exercise or compliance with the programme e.g., dementia, arthritis, wheelchair bound.

Prior to the starting of the programme, the respiratory physicians, respiratory nurses, and respiratory physiotherapists conducted a triage session to test the suitability of the referrals based on the above inclusion and exclusion criteria.

The method component of the thesis is described in the consort flowchart Figure 4 below bracketed in red. The flowchart described the normal pulmonary rehabilitation pathway after a referral was received on the left hand side of Figure 4. The flowchart also describes the two main sources of the home-based pulmonary rehabilitation programme referrals: the *declines* and *withdraws*. The *declines* were people who were referred and were accepted into the centre-based pulmonary rehabilitation programme but did-not-attend (declined) on the first telephone contact. The *withdraws* were people who were referred, accepted, and attended some parts but were unable to complete a centre-based programme. Participants from the two groups were listed as the potential home-based pulmonary rehabilitation programme participants. Because these potential home-based pulmonary rehabilitation participants may

have sat in the system for quite some time (years in some instances), for safety reasons they were reviewed and triaged once again by a respiratory physician and a respiratory physiotherapist.

2014/15 Canterbury Home-based Pulmonary Rehabilitation Consort Flowchart with the Method component in bracket.

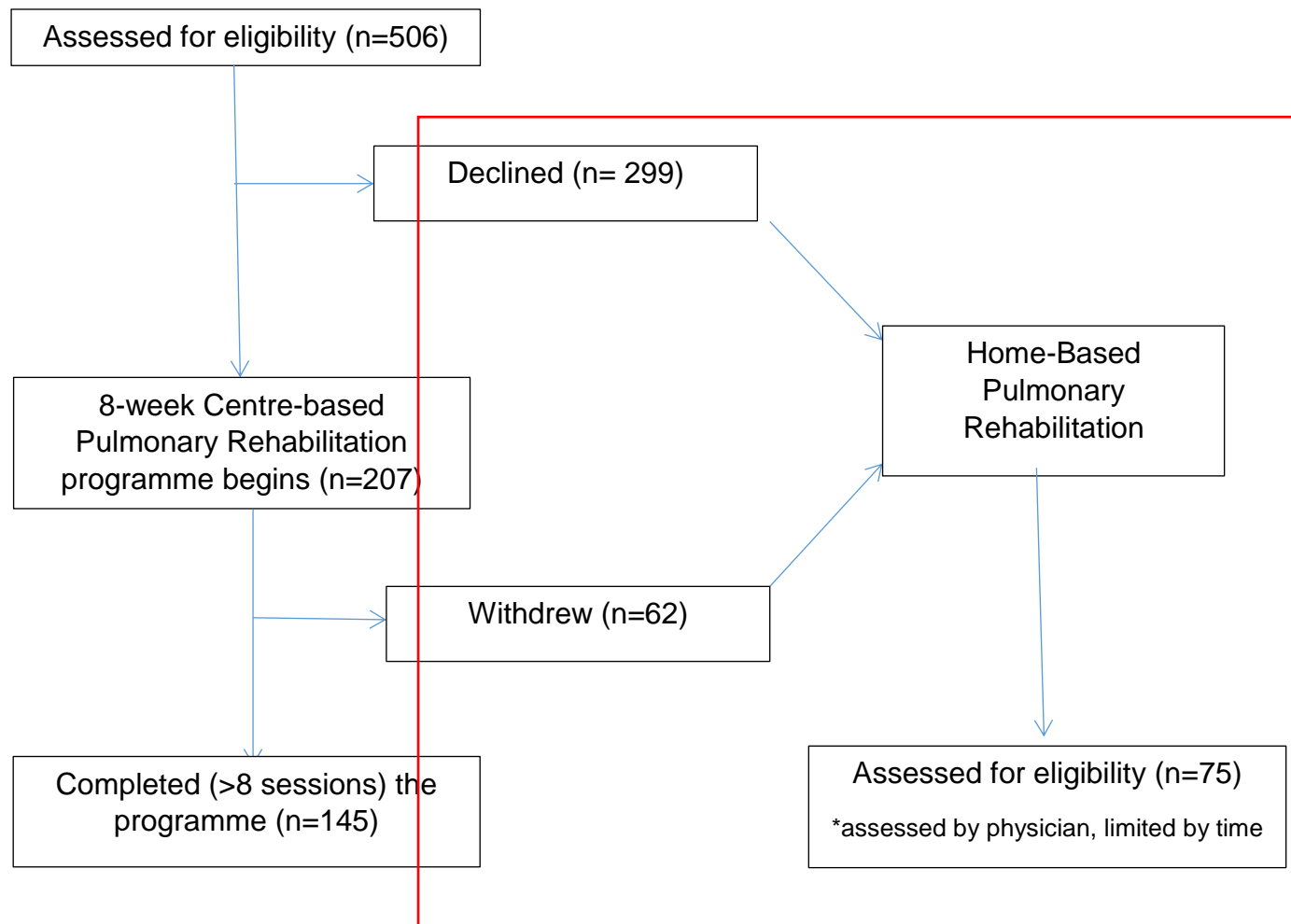


Figure 4. HBPR consort flowchart with the method component in the red bracket.

Content of intervention

The home-based community pulmonary rehabilitation patients were assessed by a respiratory physiotherapist before starting the programme. All patients were shown the education components of the “Move on up” DVD, which discusses the topics of importance, such as exercise for people living with COPD, breathing retraining, and personal stories from people living with COPD.

The home-based community pulmonary rehabilitation team delivered the education and exercise components of the programme similar to that of a gold standard Centre-based Pulmonary Rehabilitation Programme. The topics that were covered include anatomy of the lungs, breathing techniques, respiratory diseases, chest clearance, the importance of exercise and stretching, goal setting, eating well, smoking cessation, medication management, inhalation devices and techniques, osteoporosis, stress and relaxation, energy conservation, sleep hygiene, a COPD self-management plan, and maintaining focus and sustaining gains. However, unlike the centre-based community pulmonary rehabilitation programme where each topic is covered by an expert speaker; the home-based community pulmonary rehabilitation team would identify patient’s topics of special interest during the pre-programme assessment and offer individualised advice and direction. Patients would be referred to other clinical specialist/ expert intervention if deemed high risk in any categories of the patient’s wellbeing. All of the patients involved in the programme were given an information pack. The information pack included the “Move on up” exercise DVD, a ten-week walking diary (eight weeks to complete during the programme and two extra weeks for after the programme had been completed), “A guide to living positively with chronic obstructive pulmonary disease” (3rd edition revised), a COPD Blue Card (a self-management guide), healthinfo keyword search card (<http://www.healthinfo.org.nz/>), and my (researcher’s) contact details.

The patients were instructed to do the exercises according to the “Move on up” DVD (Figures 5 and 6). Patients were asked to complete a walking diary, ideally on a daily basis over the eight weeks’ duration of the programme. The patients were informed that there would be a weekly telephone call or text message to maintain their interest in the programme and answer any questions they came up during the programme.

The “Move on up” DVD exercises included three components: warm up, work out, and cool down sessions. In the warm up session the DVD took the participants through some seated stretches to the neck, shoulder, and back. The work out session included low-medium impact exercises to the lower and upper limbs aiming to improve participant’s strength and endurance. The cool down session included back and lower limb stretches in a standing position, with support as required. The DVD package also included an exercise book where each of the exercises was printed out in photographs with instructions for participant’s quick reference.

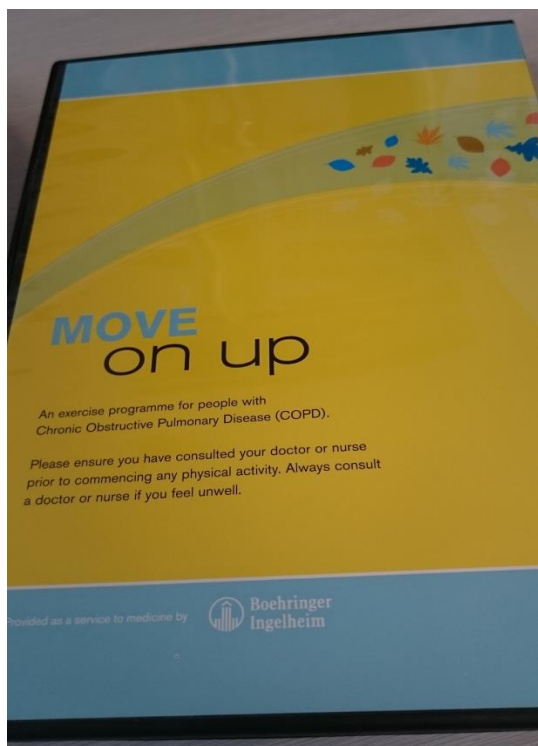


Figure 5. The Boehringer Ingelheim “Move on up” information and exercise DVD

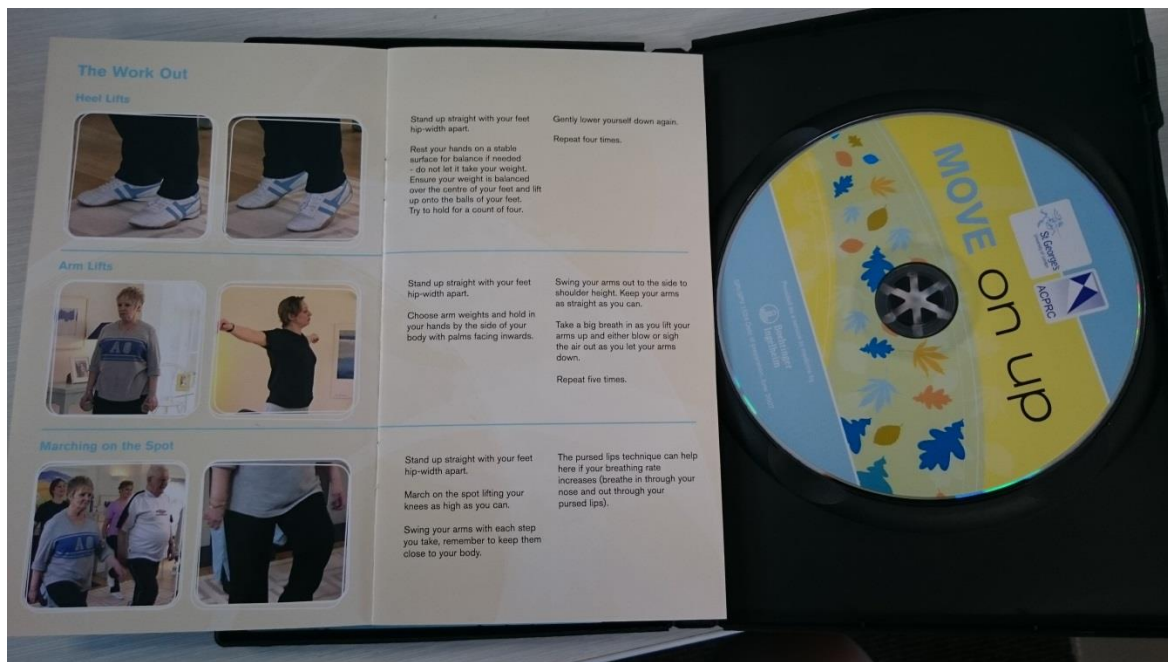


Figure 6. Inside of the “Move on up” DVD with the exercises printed out in a booklet

The participants were given a ten-week walking diary to help them establish their daily exercise routine (Figure 7). A ten-week walking diary was provided instead of an eight-week diary and this was to encourage the participant to keep on going upon completion of the programme and to consolidate the exercise component into the participant’s daily living routine. The diary included fields to record the day of the week on which the exercise was taken, minutes walked, a Borg score, and any other comments at the end of the exercise session. The Borg scale measures how hard one sees himself/herself exerting or working (Borg, 1982). The scale ranges from zero to ten, zero being *not feeling the work out at all* and ten being the *maximum*. By using the walking diary it is hoped that participants are encouraged to formulate short term and long-term goals, which will add purpose to doing exercises.

Walking Diary

Day/Date	Minutes walked	Borg (Exertion)	Comments
Week 1			
Week 2			
Week 3			

Short Term Goal

Long Term Goal

Borg Scale of Exertion
Exertion required

0 Nothing at all

0.5 Very, very slight (just noticeable)

1 Very slight

2 Slight

3 Moderate

4 Somewhat severe

5 Severe

6

7 Very severe

8

9 Very, very severe (almost maximal)

10 Maximal

- 19 -

Figure 7. All participants were given a walking diary.

All participants were also given the “A guide to living positively with chronic obstructive pulmonary disease” booklet (Figure 8). This booklet was produced by the Cardiorespiratory Integrated Support Services (the Canterbury District Health Board) with the support of Boehringer Ingelheim, the pharmaceutical company. The booklet contained useful information on the management of COPD in an easy-to-understand manner. It covered numerous valuable topics such as medication use, pulmonary rehabilitation, clearing phlegm from the lungs, controlling breathlessness, nutrition facts for people living with COPD, anxiety and depression management. The booklet was a useful tool for the participants to refer to if they had forgotten any strategies or information discussed at the initial interview session.

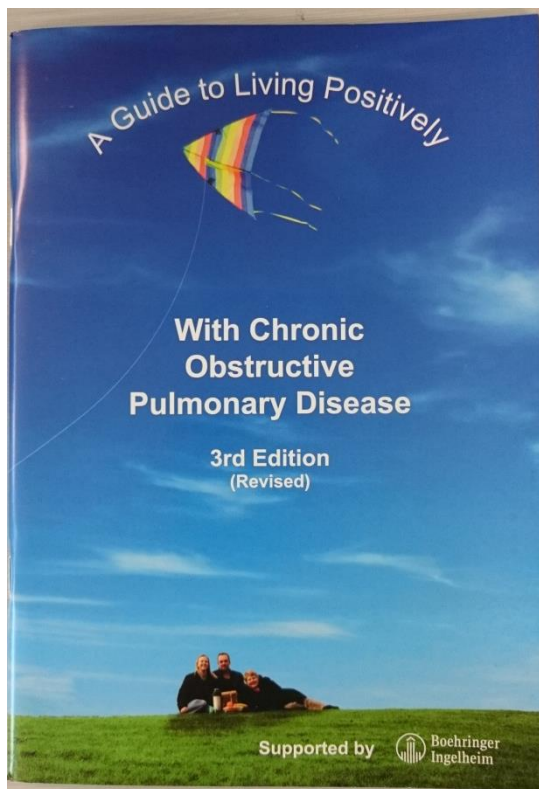


Figure 8. “A guide to living positively with chronic obstructive pulmonary disease” booklet.

The COPD Blue Card (a self-management guide) in the information pack is used widely in the Canterbury region. It was produced by the Integrated Respiratory Services, Canterbury Clinical Network (see Figures 9). The purpose of the card is to assist people living with COPD to determine what is normal or abnormal for them and when they should seek health intervention. The Blue Card included information on identifying what are the normal baseline values and symptoms and with advice on what to do if there were any deviations from the normal parameters.

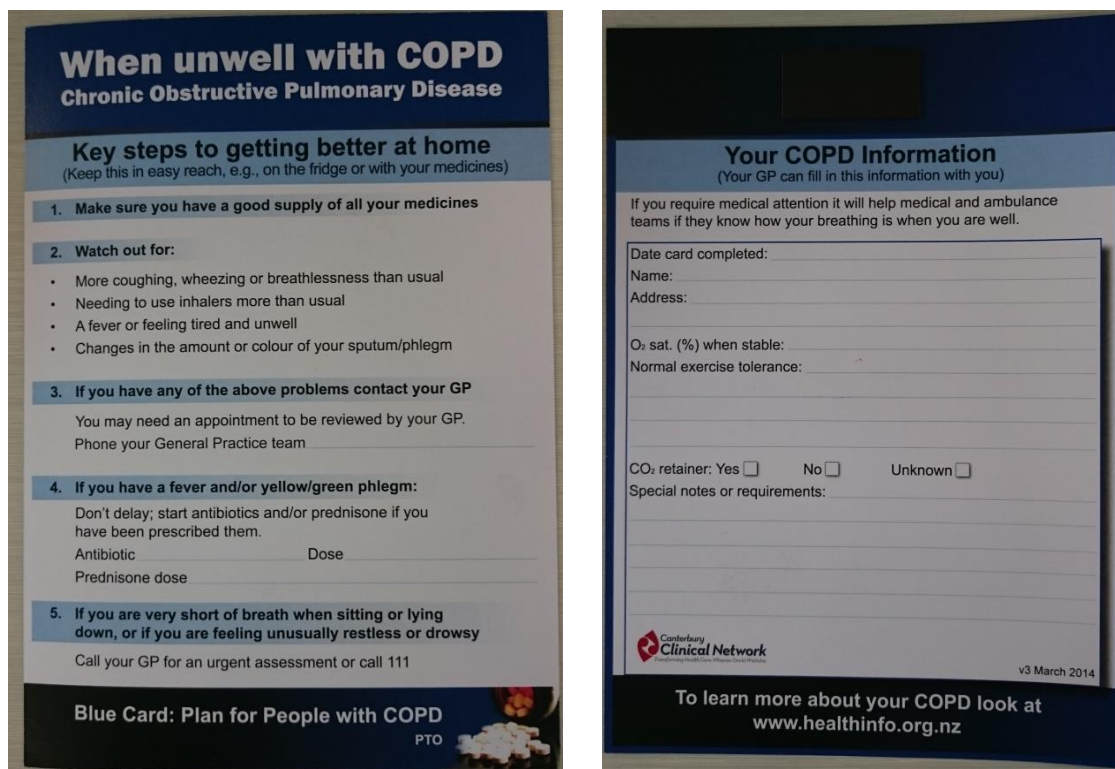


Figure 9. The front and back of the Canterbury Blue Card- A self-management plan for people living with COPD.

The CDHB produced the business-card-sized Healthinfo keyword search card to assist the more technological savvy and Internet capable participants to access the relevant medical information on topics relating to COPD (see Figure 10). The Healthinfo webpage (www.healthinfo.org.nz) was funded by the CDHB and all the information listed on the webpage was approved and supported by the local health professionals. One of the intentions of the webpage was to avoid unnecessary confusion the patients may experience if a search on a medical condition was done on a normal Internet search engine.



Figure 10. A Healthinfo keyword search card.

I also included my business card so the participants would have my contact details, both direct dial number and mobile phone number in case the participants wanted to communicate with me by text messaging.

The aim of the package was to support the participants to learn more about their breathing condition and how to manage it. The walking diary and the exercise DVD would encourage the participant to breathe better through exercising. The information booklet, the Blue Card, and the healthinfo card would encourage the participant to gain more knowledge and start to feel more comfortable about managing the breathing condition they are living with. Figure 11 shows the overall home-based pulmonary rehabilitation journey for the participants in this thesis project and the components involved in the process.

The Home-Based Pulmonary Rehabilitation Journey.

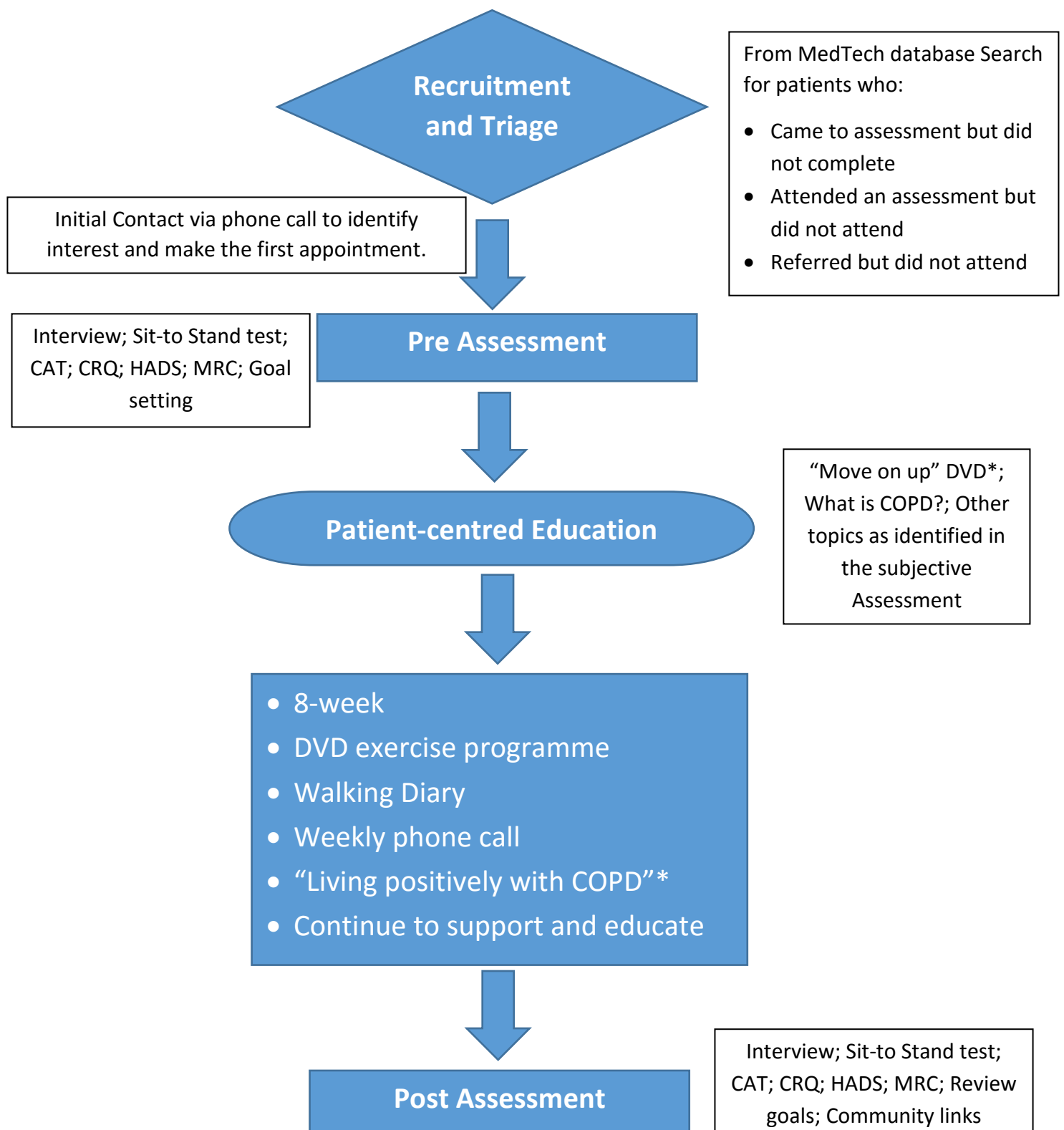


Figure 11. The Home-based Pulmonary Rehabilitation Programme process

Staff involvement

The CRST provided the clinical staff (physiotherapist or nurses) required for the Home-based Pulmonary Rehabilitation Programme. The team of clinical staff all had more than 10 years of clinical experience and were considered to be experts in the community pulmonary rehabilitation area.

Outcome measures

Primary outcome measure

Evidence on the selected objective COPD measures in this study

The objective measures used in this study were the current (2016) objective assessment measures used in the local centre-based pulmonary rehabilitation programmes. Below is a brief summary and the evidence for the use of the objective measures.

Chronic Respiratory Questionnaire (CRQ)

This well validated questionnaire was developed by Guyatt et al. (1987), where they interviewed 100 patients living with chronic airflow limitation. The research team then identified 123 items that were problematic for these patients in their daily activities. The patients rated the 123 items according to their importance and occurrence. The most important and frequent items were classified into four main themes or dimensions: dyspnoea, emotion, mastery, and fatigue. These four themes formed the backbone of the CRQ. The dyspnoea dimension described how the patient was affected by breathlessness because of their chronic lung condition. The emotion dimension depicted the emotional function, anxiety, and depression included, of a patient living with breathing conditions. The mastery dimension described the feeling of control the patient had over the disease. Lastly, the fatigue dimension depicted the amount of tiredness the respiratory diseases patients had in their activities of daily living. Guyatt et al. (1987) then tested the responsiveness of the CRQ on patients by using the questionnaire before and after optimisation of the drug therapy and also

before and after the patient had attended a respiratory rehabilitation programme. The results from the two groups suggested the CRQ was a precise, valid, and responsive disease-specific tool in measuring a patient's quality of life. In 1994, Wijkstra et al. examined the reliability and validity of the CRQ. Wijkstra and team found that in their 40 patients, the CRQ was a highly reliable and valid measure for the fatigue, emotional function, and mastery dimensions but less so in the dyspnoea component (Wijkstra et al (1994). To date the CRQ has translated into a number of languages and used in many countries around the world. The CRQ was translated and reviewed in the German (Puhan et al., 2004), Taiwanese (Meng et al., 2011) and Colombian (Álvarez et al., 2015) populations and in each instance the questionnaire was shown to be a valid and reliable quality of life measurement for people living with chronic respiratory illnesses.

Answers to the questionnaire are converted to numerical values. A mean value change of 0.5 per dimension, and an overall improvement of two is considered to be clinically significant (De Torres et al., 2002; Jaeschke et al., 1989). A copy of the questionnaire can be found in Appendix B.

Secondary outcome measures

One-minute sit-to-stand test (1MSTST)

The 1-minute sit-to-stand test (1MSTST) is an assessment tool to assess the functional status of the patients (Ozalevli et al, 2007). The 1MSTST was performed using standardised instructions at the pre-programme assessment session and the test was repeated at the post-assessment session. The number of repetitions of sit-to-stand were recorded and compared before and after the intervention. The evidence supporting the use of 1MSTST as a simple and practical objective measure for exercise capacity is on the rise, despite this, most literature examined the exercise capacity of COPD patients using the more well-known 6-minute walking test (6MWT). Ozalevli and colleagues (2007) analysed the correlation between the

1MSTST and the 6-minute walking test and found there was a close association between the tests. Ozalevli and colleagues reported strong correlation was found between the 1MSTST and 6MWT in the COPD population with $r = 0.75$ ($p < 0.001$) and a less strong correlation of $r = 0.54$ ($p = 0.04$) in the healthy population. The authors, therefore, suggested the 1MSTST produced similar assessment to the functional status of a person living with COPD; however, the 1MSTST was less stressful for the patients to perform. More recently, the 1MSTST was also tested in the cystic fibrosis, haemodialysis and pain management programme patient populations. Radtke et al. (2016) tested the 1MSTST on people living with cystic fibrosis and found the 1MSTST to be reliable, valid, and feasible when used to measure the physical function. The authors also suggested a minimal clinical important difference to be five repetitions. A minimal clinical important difference is a measure which determines when a change is clinically relevant. Its official definition is “the smallest difference in score, which patients perceive as beneficial and which would mandate a change in the patient’s management” (Jaeschke et al., 1989). In other words, for the cystic fibrosis population, Radtke and colleagues (2016) suggested if there were a change of five repetitions in the before and after tests, the clinical team would need to review the patient’s management plan. Segura-ortí et al. (2011) suggested the 1MSTST to be one of the reliable outcome measures for patients undertaking haemodialysis. The authors in this study had suggested a minimal clinical important difference of four repetitions. Lastly Simm et al. (2014) examined the efficacy of their pain management programmes using the 1MSTST. They have adopted the Segura-Orti et al. (2011) minimal clinical important difference of four repetitions in their study and found it a useful measure to the function of their chronic pain patients.

COPD Assessment Test (CAT)

Jones et al. (2009) developed the COPD Assessment Test (CAT) with the aim of creating an easy, but valid, life impact assessment tool for people living with COPD. Jones et al. (2009) identified eight stand-out themes from their qualitative research on people living with COPD and these eight themes formed the backbone of the CAT. The eight items identified were cough, phlegm, chest tightness, breathlessness, activities, confidence, sleep, and energy. Jones et al. (2009) then conducted analyses on differential functioning between countries, internal consistency, and tested the correlation of the CAT to the well validated St George's Respiratory Questionnaire (SGRQ). Jones and colleagues (2009) had identified a strong correlation between the CAT and the COPD-specific SGRQ with $r = 0.8$ ($p < 0.0001$) in the stable COPD patients and $r = 0.78$ in acute patients with exacerbation. The analyses and tests revealed the CAT was a short and simple, but at the same time sensitive and reliable, standardised measure for people living with COPD and it had worldwide relevance (Jones et al., 2009). The CAT was also examined by Kon et al. (2013) on patients who had other chronic respiratory conditions in the pulmonary rehabilitation setting. Their results suggested the CAT was as responsive to change in the non-COPD population when compared to the counterpart COPD population. Kon et al. (2014) established a minimal clinical important difference for the CAT. After studying 1,565 sets of paired CAT the authors suggested a change of 2 points to be clinically important, which in practice means a reduction of two points is considered to be a clinically important improvement and an increase of two points represents a clinically important deterioration (Kon et al., 2014). A copy of the CAT questionnaire is presented in Appendix C.

Hospital Anxiety and Depression Score (HADS)

The Hospital Anxiety and Depression Score (HADS) was used to monitor and assess the mental wellbeing of the patients. Zigmond and Snaith first developed the now well validated

HADS score in 1983 (Zigmond & Snaith 1983). It was initially developed to identify anxiety disorders and depression among patients visiting the non-psychiatric hospital clinics (Zigmond & Snaith 1983). Bjelland et al. (2002) undertook a literature review on the validity of the HADS. They examined 747 papers identified from the PsycINFO database and tested the papers based on three standardised questions on the validity and consistency of the HADS. They reported from the review both the sensitivity and specificity of the HADS were high and both had a range of 0.70 to 0.90, (Bjelland et al., 2002). The HADS tool appeared to be a good, if not excellent, case-finding assessment tool for anxiety disorder and depression (Bjelland et al., 2002). A Chinese cross-sectional case control study carried out by Lou et al. (2012) on 1,100 COPD patients found the prevalence for people living with COPD and depression was five times more than people living without COPD (35.7% vs. 7.2%). The results also showed people living with COPD and anxiety issues were over three times more prevalent than people living without COPD (18.3% vs. 5.3%). In Switzerland, Nowak et al. (2014) concurred with the findings reported in Lou et al. (2012) study. The results from their ongoing prospective observational cohort study on 259 COPD participants suggested the clinicians needed to be more aware of the significant higher prevalence of psychological comorbidities in people living with chronic respiratory illnesses. These findings all pointed towards the importance of screening people living with COPD for anxiety and depression symptoms, using the questionnaire (Nowak et al, 2014). A copy of the HADS questionnaire is presented in Appendix D.

EQ-5D health-related quality of life questionnaire.

EQ-5D quality of life score was also used in this research. The EQ-5D has shown to have the ability to measure the health of a population and detecting changes in the subgroups (Kind, Dolan, Gudex & Williams, 1997). The EQ-5D 3L used in this thesis project consists of two domains, the EQ-5D index and the EQ-5D visual analogue domains. The EQ-5D index domain consists of five general quality of life questions. These questions attempt to establish

the mobility, self-care, usual activity, pain/discomfort and anxiety/depression statuses of the person. There are three answers to each of the five aspects-of-life questions, the person either *has no problems*, *some problems* or *a lot of problems* in the area asked. The EQ-5D visual analogue domain attempts to determine how well or unwell the person feels about their health state by providing a zero to a hundred scale, with the zero end meaning the *worst imaginable health state* and the hundred, *best imaginable health state*. Pickard et al. (2008) conducted their study on validating the use of EQ-5D in people living with COPD and estimating a set of EQ-5D utility scores that could be linked to the different stages of COPD. The study's results supported the use of EQ-5D in people living COPD. Pickard et al. (2008) suggested the EQ-5D scores could better inform the clinician on the wellbeing of the patient to allow better decision-making and resource allocation. Zanini et al. (2015) estimated a minimal clinical important difference to the EQ-5D visual analogue scale score (range from zero to 100) for people living with COPD in a pulmonary rehabilitation setting. The authors have found a change of eight units out of a possible 100 units is considered to be clinically important. They had also found through the EQ-5D visual analogue, those people living with poorly managed COPD benefitted the most from attending a pulmonary rehabilitation programme (Zanini et al., 2015). A copy of the EQ-5D questionnaire and visual analogue scale (VAS) is presented in Appendix E.

Summary.

The home-based pulmonary rehabilitation programme had similar format to the Centre-based Pulmonary Rehabilitation Programme. The inclusion and exclusion criteria, assessment tools used, and most of the participant resources would be the same. The main differences will be in the recruitment component and the intervention content between the two programmes. In the home-based pulmonary rehabilitation programme the participants were not recruited from fresh referrals from the health professionals, the participants were re-discovered from the

decline and withdraw groups of the pre-existing pool of referrals. The home-based pulmonary rehabilitation intervention content contained one extra resource, the “Move on up” DVD.

This addition was meant to offer the home-based pulmonary rehabilitation programme participants more opportunities to learn about their condition, which would otherwise have been shared and supported regularly in the centre-based pulmonary rehabilitation programme.

In the next chapter, I discuss the result findings from the implementation of the methods described in this chapter.

Chapter 4: Results

The results presented in this chapter examines firstly the demographic characteristics of the home based and centre based groups both descriptively and interpretively, secondly the intervention outcomes across both groups, and thirdly, the Patient Satisfaction Survey results.

Demographic profile of the home based and centre based groups

The before and after intervention data were collected over two two-week periods approximately two months apart. At both home visits (home based group) the participants completed the study questionnaires and the one-minute sit-to-stand test. The “before intervention” data sets were collected during the period of 8th to 19th December 2014. The “after intervention” data collection was done during the period of 23rd February to 9th March 2015. Of the original 75 participants, who were assessed and deemed suitable for the home-based pulmonary rehabilitation programme, on initial telephone contact, 29 participants declined to participate in the home-based pulmonary rehabilitation (rate of decline $29/75 = 39\%$). The reasons varied from ill health, other commitments to the patient did not wish to participate. The remaining 46 participants were offered a pre-programme assessment date. Unfortunately, 16 of these participants withdrew from the programme after the initial appointments were scheduled ($16/46$ declined = 35%). The reasons varied from ill health or to the patient not being at home at the agreed time of the visit. On a more positive note, two of the 16 participants who withdrew from the home-based pulmonary rehabilitation programme were re-referred to the centre-based pulmonary rehabilitation programme due to a change in their life or work situations.

Altogether 30 participants started the home-based pulmonary rehabilitation programme. Seven participants withdrew from the programme for personal reasons and medical illnesses ($7/30 = 23\%$ failed to complete the programme. One of the seven died. A further two participants ($2/23 = 9\%$) withdrew when contacted to make a post-programme assessment appointment, one had a bad viral flu and the other had surgery in the post-assessment week.

Hence a total of 21 patients completed the full home-based pulmonary rehabilitation programme, this is shown in Figure 12 below.

As discussed in the Chapter on methods, a minimum of 63 centre-based patients from the database would be required to have a 1:3 home-based pulmonary rehabilitation programme: Centre-based ratio of participants in the research. Seventy control patients were randomly selected from the COPD health service database. The demographic profile of the study participants is shown in Table 1.

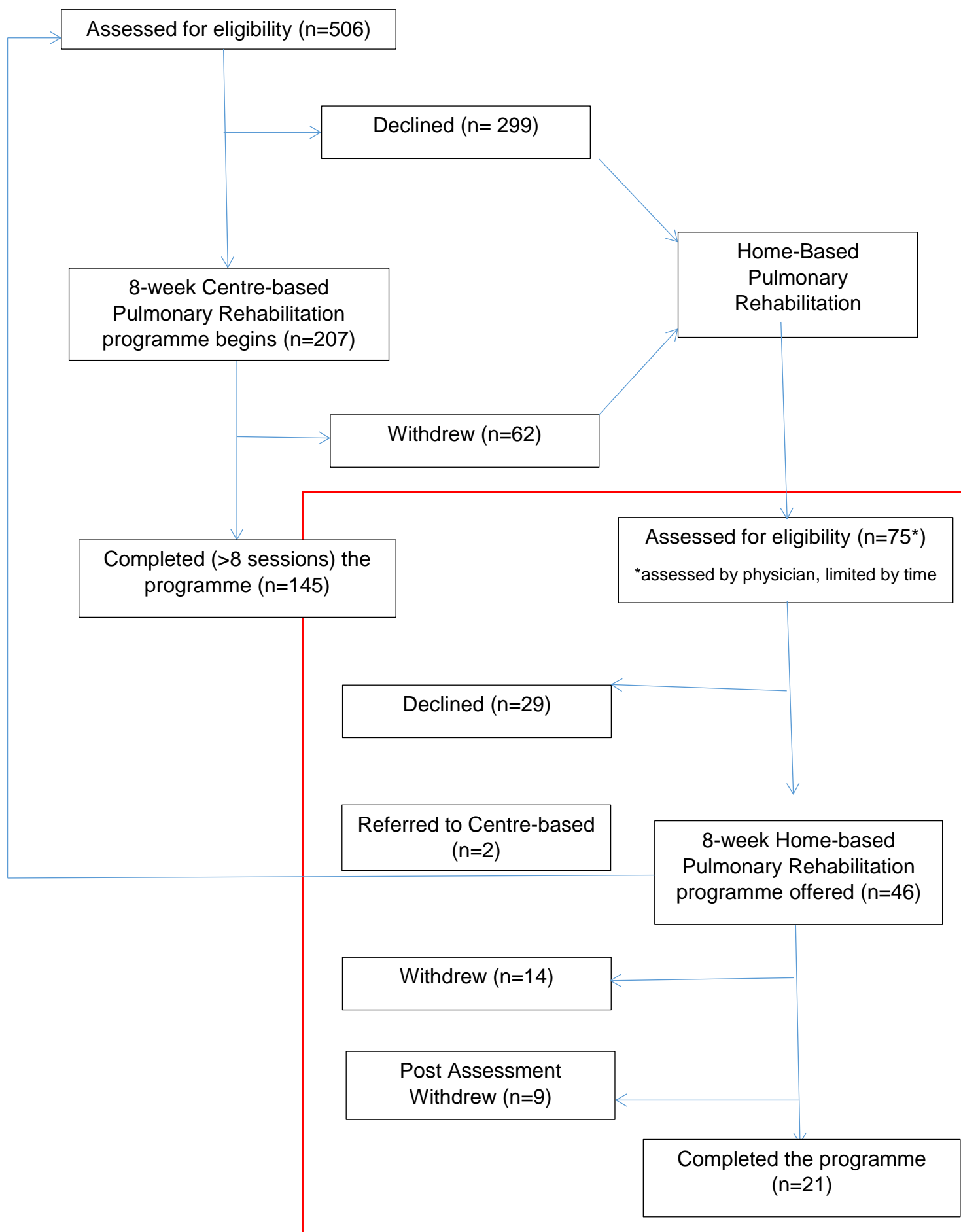


Figure 12: 2014/15 Canterbury Home-based Pulmonary Rehabilitation Consort Flowchart

Table 1. The demographic profile of participants at baseline

Variable		home-based pulmonary rehabilitation programme group	Centre-based group
Sample size		21	70
Gender	Male	11 (52%)	24 (34%)
	Female	10 (48%)	46 (66%)
Mean age in years		68.76	74.61
Ethnicity	NZ European/Pākehā	15 (71%)	52 (74%)
	NZ Māori	3 (14%)	3 (4%)
	European not otherwise specified	2 (10%)	2 (3%)
	Pacific Island	0	0
	Asian	0	0
	Other	1 (Dutch, 5%)	12 (3 other European, 9 Other, 17%)
	Not specified	0	1 (1%)
Spirometry	Mild (FEV1 > 80%)	0	2 (3%)
	Moderate (50% < FEV1 < 80%)	5 (24%)	26 (37%)
	Severe (30% < FEV1 < 50%)	11 (52%)	28 (40%)
	Very Severe (FEV1 < 30%)	4 (19%)	14 (20%)
	No FEV1 data	1 (5%)	0
CRQ (mean)	Dyspnoea	14.2	15.8
	Emotional Function	30.1	32.9
	Mastery	18.7	19.1
	Fatigue	13.7	15.8
HADS (mean)	Anxiety	7.0	6.6
	Depression	5.6	5.0
1MSTST (mean)		18.3	Did not perform
CAT score (mean)		19.7	Did not perform
EQ-5D (mean)	Index	0.59	0.62
	Visual analogue	5.85	6.67

Outcome analysis: baseline data

The SPSS statistics programme was the main statistic tool used to analyse the data. The primary outcome measurements; the CRQ, HADS and EQ-5D, were tested for their normality by looking at their Q-Q plots, Kurtosis (lop-sidedness of the distribution), Skewness (peakedness or flatness) and Shapiro-Wilk values.

In SPSS a Kurtosis range of ± 1 reflects a very good normal distribution and ± 2 reflects an acceptable normal distribution. The Skewness range is similar to the Kurtosis value. A value of zero suggests a symmetrical distribution, but values between ± 1 to ± 2 are considered to be acceptable. The Shapiro-Wilk test values were also referred to in determining the data sets' degree of normal distribution (SPSS, 2015). For the purpose of this research and to be consistent with international studies, a p -value of <0.05 was considered statistically significant.

The SPSS statistic software, contains the quantile-quantile plot or Q-Q Plot, which is a graphical method in determining whether the data is normally distributed. A 45 degree reference line is drawn in the middle of the graph. If the data set is normally distributed, the values should fall approximately along the reference line. The collected data and the change values in this research project appeared to be following the linear reference line closely on the Q-Q Plot. These generated graphs are therefore suggesting that the collected values are likely to follow a normally distributed pattern. Below are two classic examples of the Q-Q Plot distributions in the analysed outcome values and presented in Figure 13, other Q-Q Plot graphs can be found in Appendix A.

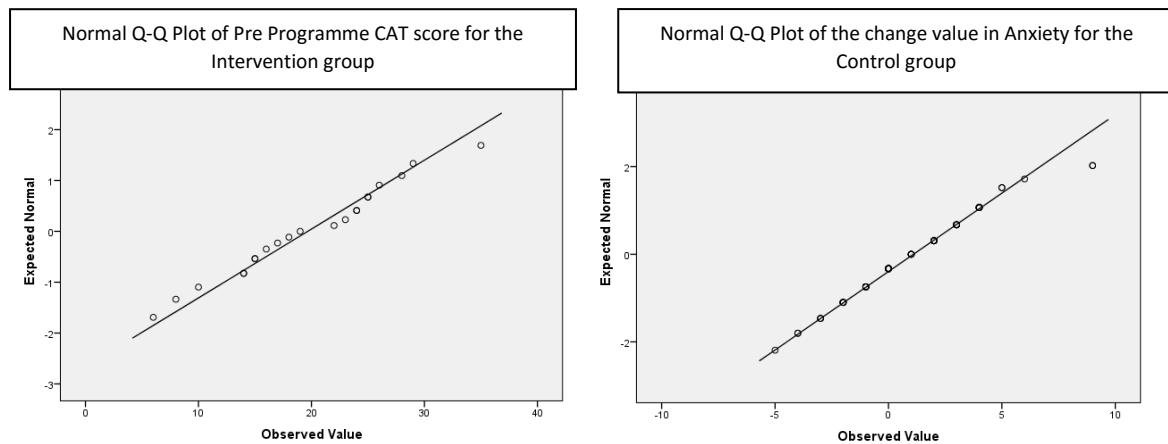


Figure 13: Examples of the Q-Q plot graphs generated from the data.

The Kurtosis and Skewness values for the parameters were mostly within the acceptable range to suggest that the data followed a normal univariate distribution. The only two exceptions were the pre-programme depression value for the control centre based group and the pre-programme EQ-5D index value for the home based group. In the pre-programme values the Shapiro-Wilk test suggested the EQ-5D index value and CRQ mastery value of the home based group and the depression value, the EQ5D index and the CRQ dyspnoea value for the control group were not normally distributed. The Shapiro-Wilk test also suggested that the post-programme parameters, other than the anxiety and dyspnoea values, most of the control group values were not normally distributed. In the post-programme home based group, there were only two parameters, EQ-5D index and CRQ emotional function that were not normally distributed (p -value < 0.05).

Below Table 2 consisted the Kurtosis, Skewness and Shapiro-Wilk test values for the pre-assessment and post-assessment and the change measured between the pre and post assessments.

Table 2. Normality analyses to the parameters

	Parameter	Kurtosis (Home based/ Centre based)	Skewness (Home based/ Centre based)	Shapiro-Wilk (Home based/ Centre based)
Pre programme	Anxiety	-.910/ -.631	.045/ .284	.616/ .127
	Depression	-.680/ 3.304*	-.399/ 1.264	.075/ .000*
	EQ5D Index	4.322* / 1.163	1.473/ .586	.012* / .000*
	EQ5D Analogue	-.331/ -.655	-.107/ -.224	.695/ .055
	CRQ Dyspnoea	.457/ .148	.813/ .742	.289/ .008*
	CRQ Fatigue	-1.214/ -.363	.286/ -.197	.097/ .211
	CRQ Emotion	.757/ -.961	.345/ .123	.880/ .085
	CRQ Mastery	-1.353/ -.158	-.342/ -.344	.032* / .087
Post programme	Anxiety	.969/ -.560	.097/ .309	.474/ .079
	Depression	.935/ -.052	1.018/ .726	.077/ .000*
	EQ5D Index	-.110/ .630	.273/ -.007	.028* / .000*
	EQ5D Analogue	-.891/ -.287	-.240/ -.492	.590/ .018*
	CRQ Dyspnoea	-.788/ -.766	-.208/ .114	.616/ .194
	CRQ Fatigue	-1.222/ -1.088	-.170/ -.254	.146/ .007*
	CRQ Emotion	.836/ -.978	-1.143/ -.363	.016* / .007*
	CRQ Mastery	-.970/ -.381	-.364/ -.675	.185/ .001*
The Change	Anxiety	2.128* / .519	.866/ .368	.067/ .097
	Depression	.082/ .426	-.178/ .512	.484/ .006*
	EQ5D Index	-.633/ .324	-.134/ .278	.583/ 0.004*
	EQ5D Analogue	.263/ 2.718*	-.189/ 1.165	.326/ .000*
	CRQ Dyspnoea	-.153/ -.066	.030/ .235	.936/ .865
	CRQ Fatigue	-.509/ .261	-.318/ .287	.543/ .279
	CRQ Emotion	.200/ 1.104	-.986/ .950	.036* / .002*
	CRQ Mastery	.074/ -.593	.681/ -.124	.235/ .185

* significance level $p < 0.05$

Based on these findings I decided to carry out both the parametric and non-parametric tests to examine the null hypothesis that there is no significant difference (p -value < 0.05) between

the home-based pulmonary rehabilitation programme and the centre-based pulmonary rehabilitation programme groups in the CRQ scores and the secondary outcome measures (1MSTST, CATS, HADS and EQ-5D).

The two groups showed no significant difference in gender distribution or mean age. The home based group had an almost equal proportion of male and female participants (11:10, 52%: 48%), whereas the control centre based group had 24 males and 46 females (34%: 66%), as illustrated in Figure 14, and while this difference was not statistically significant it is worth noting that proportionally more males attended the home-based pulmonary rehabilitation than the centre-based pulmonary rehabilitation.

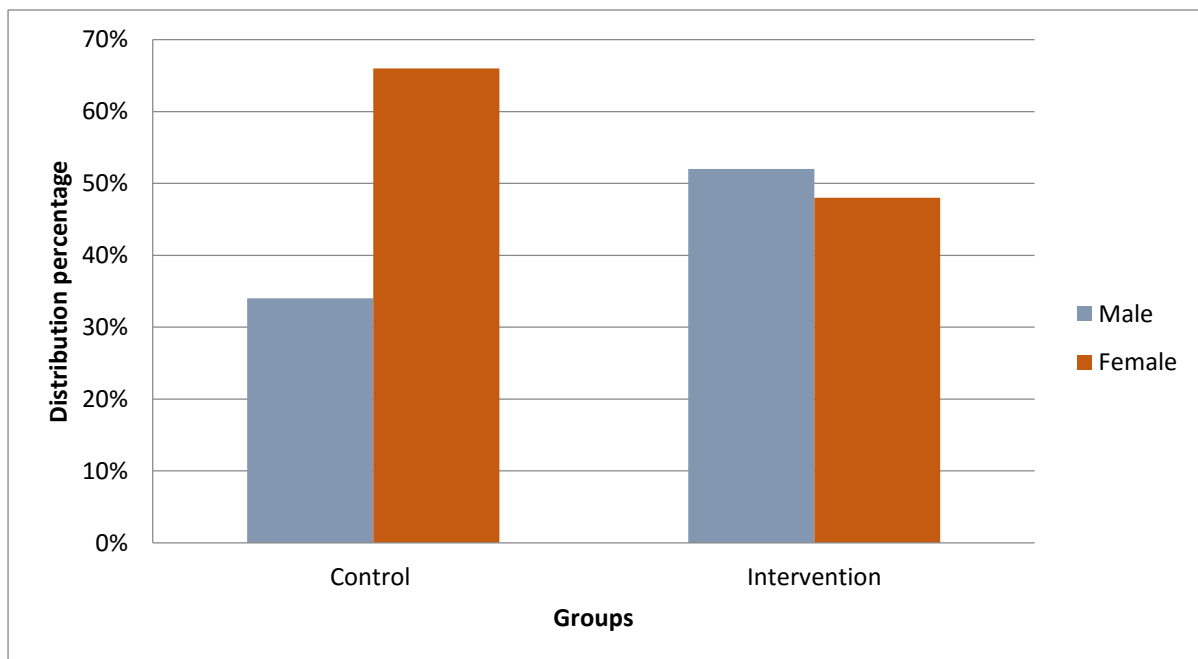


Figure 14. The gender distribution of the Control and Intervention groups.

The Chi square test was chosen to analyse the gender data of the intervention (home-based pulmonary rehabilitation programme) and control (centre-based pulmonary rehabilitation programme) groups due to the fact that gender is a categorical variable. The 2-sided Pearson Chi square value suggested no statistical difference in gender between the two groups with $X^2 = 2.235$, $p > 0.05$.

However, it was a different scenario for the age distribution. The mean age of the intervention group was 68.8 years of age, almost 6 years younger than the control group (74.6 years of age), as illustrated in Figure 15..

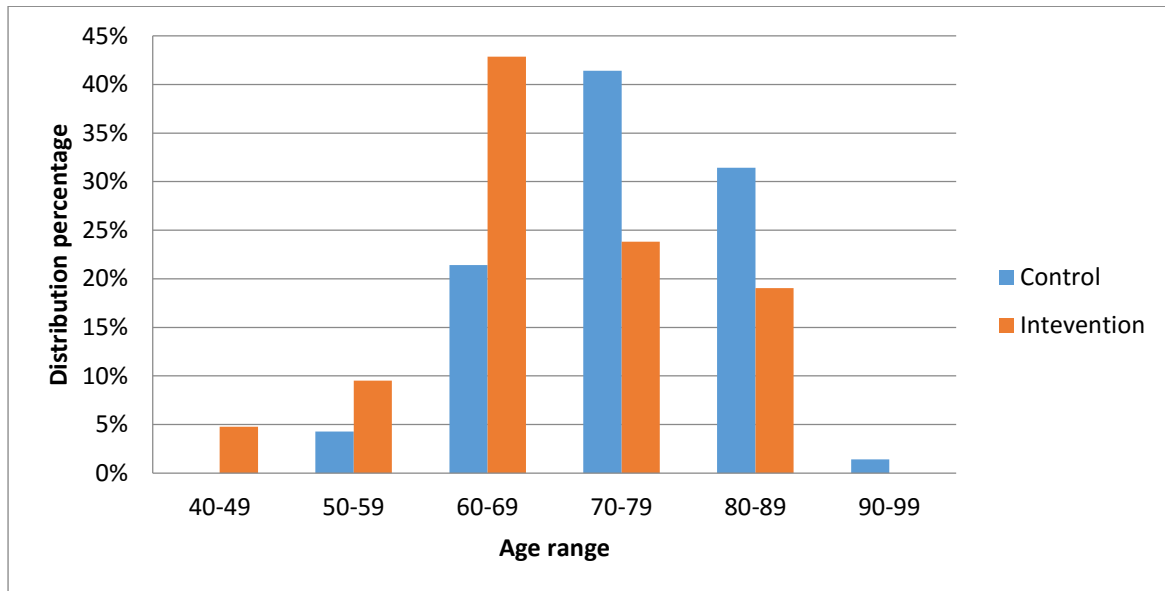


Figure 15. The age distribution in age range groups in the Control and Intervention groups.

A *t*-test was performed on the age data, assuming the age data set was normally distributed, to determine if there was any statistical significant difference between the two groups. The 2-tailed *t*-test suggested statistical significant difference in the mean age between the two groups with $t = -2.726$, $p < 0.05$, equal variances assumed.

The ethnicity distribution was similar across both groups. The majority of the participants identified themselves as New Zealand European, 71% in the intervention group and 74% in the centre based control group. However, the intervention group had a higher representation from the Māori community, although there were 3 Māori participants in each group, as illustrated in Figure 16.

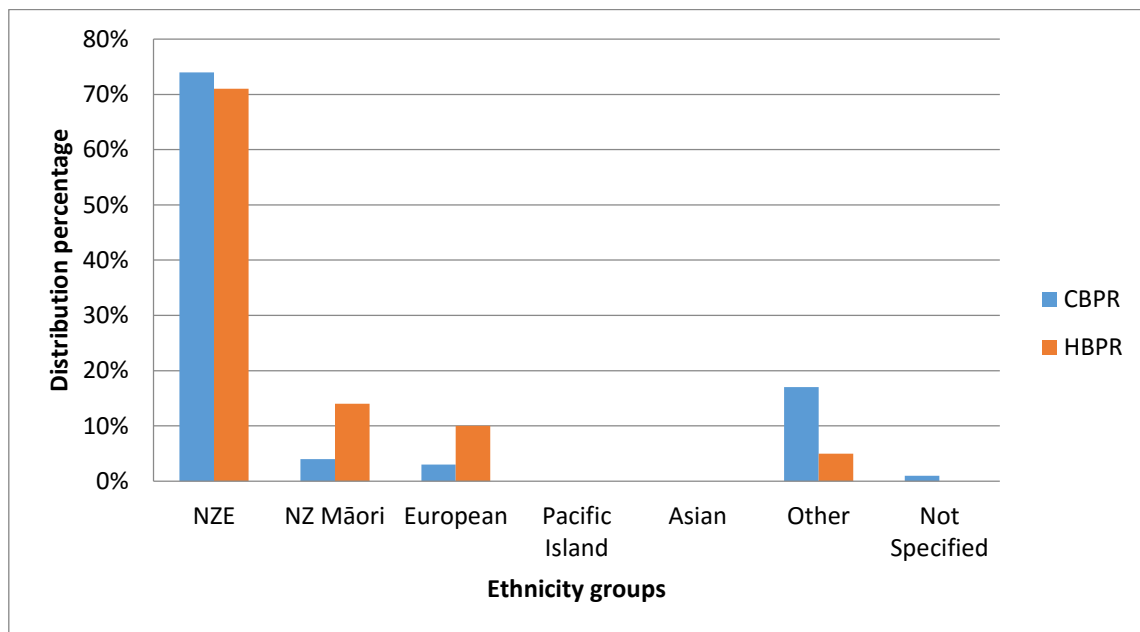


Figure 16. The ethnicity distribution in the control centre based pulmonary rehabilitation and the intervention home based pulmonary rehabilitation groups.

Once again, due to the categorical variable nature of the ethnicity data, the Chi square test was performed to determine if there was any statistical difference between the two groups. The 2-sided Pearson Chi square test suggested no statistical significant difference between the two groups in regards to the ethnicity distribution with $X^2 = 11.335$, $p > 0.05$. The forced expiratory volume in one second or FEV1 in the spirometry testing determined the severity of the participants' breathing condition. Both groups appeared to have similar mean FEV1 values at baseline. The control group had a mean FEV1 of 45% predicted value and the intervention group, 41% predicted value. That is, participants from both groups were

classified as having severe airflow obstruction, or GOLD Stage III COPD (FEV1 value between 30-50%). From the demographic data the moderately to severely obstructed patients were the majority in both groups (intervention group, 76%; control group, 77%); the very severely obstructed participants constituted approximately 20% of both groups. It is also interesting to note that the intervention group appeared to have a higher proportion of the severely obstructed participants compared to the participants in the control group (52% vs 40%), as illustrated in Figure 17.

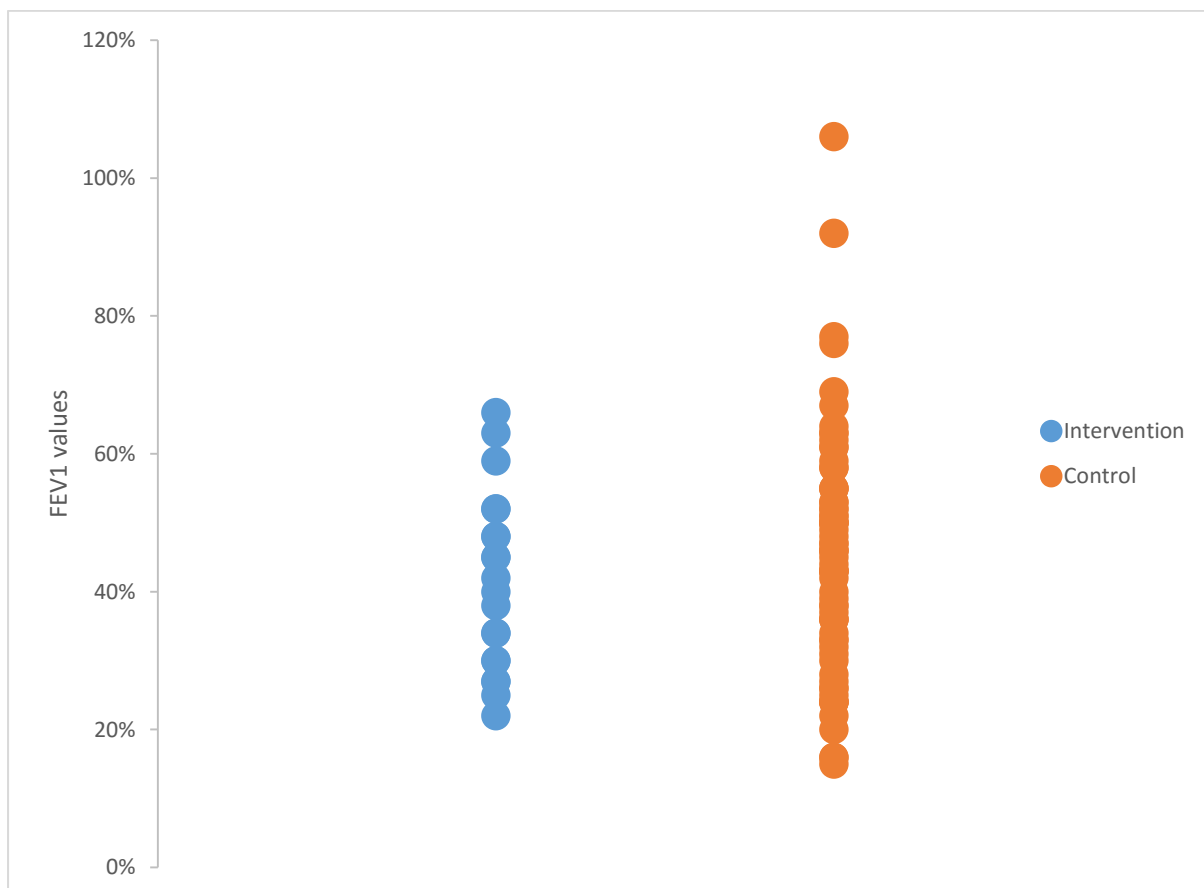


Figure 17. The severity of airway obstruction distribution in the Control and Intervention groups.

A *t*-test was performed on the FEV1 data, assuming the FEV1 data set was normally distributed, to determine if there was any statistical significant difference between the two

groups. The 2-tailed t -test suggested no statistical significant difference in FEV1 mean scores in the two groups with $t = -0.890$, $p > 0.05$, equal variances assumed.

Summary of demographic characteristics of the participants

- The data suggest that the centre based (control) group programme (Centre-based) was better attended and tolerated by female participants than male participants, to the ratio of 2:1. The home based (intervention) group (those following the home-based pulmonary rehabilitation programme and was able to reach an almost equal representation from both male and female patients.
- The mean age for the intervention group was younger than the control group by almost 6 years. The intervention group had the largest participant proportion at the 60-69 years of age subgroup, whereas the control group had the largest participant proportion at the 70-79 years of age subgroup.
- The Pulmonary Rehabilitation Programme participants were mostly New Zealand Europeans in both the intervention and control groups which represents the ethnic composition of the community they were recruited from. The intervention group was close to four times more effective in reaching out to the New Zealand Māori community when compared to the control group.
- The severity distribution between the home based and centre based groups appeared to be similar. It is worth noting, however, that the control group participants had a very gradual peak at the severely obstructed subgroup when compared to the centre based group, sharp and obvious.

The primary outcome measure

The Chronic Respiratory Questionnaire (CRQ) results

The Chronic Respiratory Questionnaire is a reliable and validated questionnaire used to assess and analyse the quality of life of people living with chronic respiratory conditions (Guyatt et al., 1987). The questionnaire has four main categories derived from 20 questions that relate to dyspnoea, emotion, mastery, and fatigue. Please refer to the Chapter on methods for the more detailed explanation of the CRQ. The response totals to each of the CRQ domains were calculated before analysis. De Torres and colleagues note that a change in the mean score of plus/minus two (the effect size) from the pre-assessment and post-assessment is considered to be of clinical significance (2002). A higher value in the questionnaire means better management (a plus change score) and a lower value means poorer management (a minus change score).

The dyspnoea data, which measured how much the participants felt breathlessness was affecting their lives, suggested before any intervention was put in place both groups appeared to have a similar level of breathlessness a higher mean score of 15.8 in the centre based control group compared to the lower mean score 14.2 in the intervention group. These values were out of a highest possible total score of 35 and the higher the score the better one feels about the level of breathlessness. At the end of the programmes, both groups' participants demonstrated improvements more than the minimal clinically significant difference (two points) on the scale. It is worth noting that people from the home-based pulmonary rehabilitation group appeared to have more dyspnoea symptoms compared to the centre-based pulmonary rehabilitation group. The result of this measure implied that both intervention methods were clinically effective; however, no one intervention was more superior to the other, as illustrated in Figure 18.

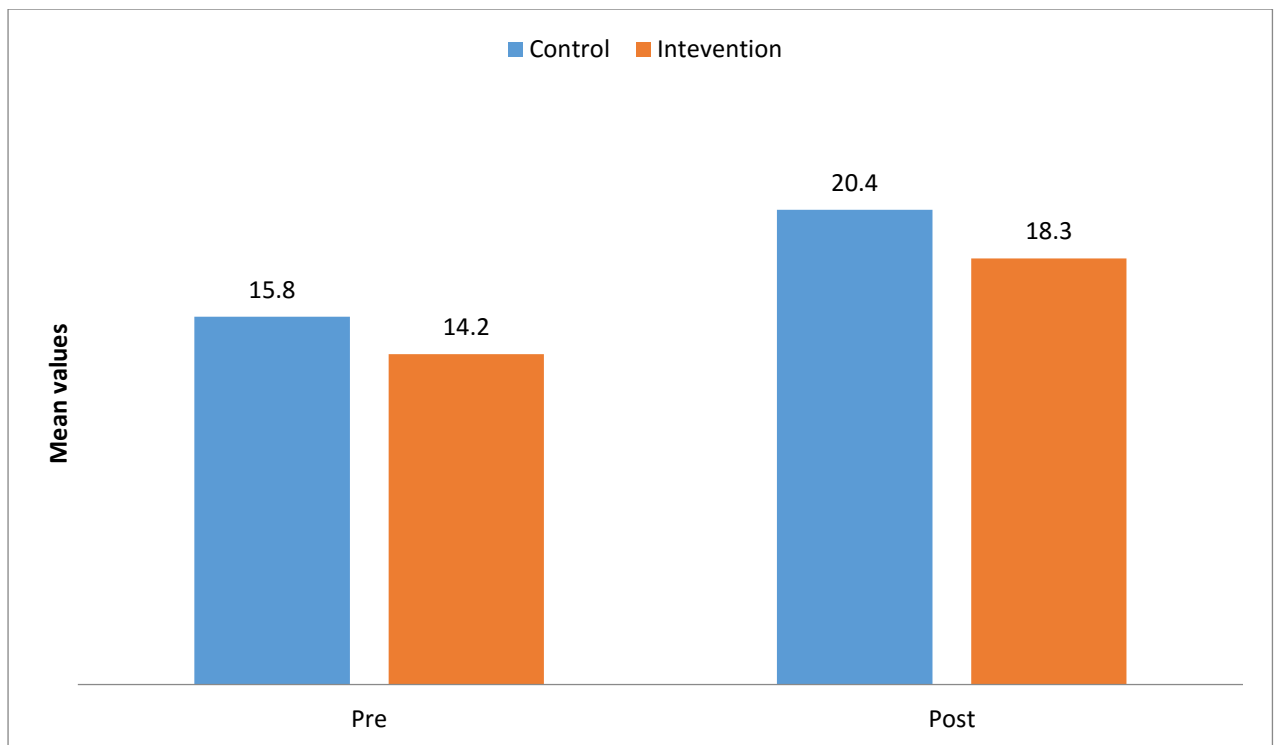


Figure 18. The CRQ dyspnoea mean values pre and post programme for the Control and Intervention groups.

The mean change difference values were calculated and analysed using the SPSS tool for both groups. The mean change difference values were then put through the parametric *t*-test and the non-parametric Mann-Whitney and Wilcoxon statistical analysis to determine if there were any significance between the change in the control group and the intervention group. In the centre-based pulmonary rehabilitation, the dyspnoea mean change value was 4.62 (ranged from -9 to 22) and in the home-based pulmonary rehabilitation the mean change value was 4.08 (ranged from -11 to 17). Both 2-tailed analyses revealed that the mean difference achieved in the home-based pulmonary rehabilitation group had no statistical significant difference to the centre-based pulmonary rehabilitation group with $t = -0.336$, $p > 0.05$; non-parametric test $z = -0.310$, $p > 0.05$. Both groups had achieved a statistical and clinically significant improvement (change value > 2) in this CRQ category (home-based pulmonary rehabilitation: paired $t = -2.623$, $p < 0.05$; centre-based pulmonary rehabilitation: paired $t = -$

6.135, $p < 0.05$). The centre-based pulmonary rehabilitation group had increased mean score by 4.6 points (doubled the minimal clinically significant value) and the home-based pulmonary rehabilitation group had a mean improvement value of 4.1 points. The centre-based pulmonary rehabilitation group appeared to have performed marginally better by 0.54 points than the home-based pulmonary rehabilitation, however the difference was 75% below the clinically significant two-point change required and statistically no significant difference was identified. These analyses suggest that the home-based pulmonary rehabilitation intervention is just as clinically effective as the centre-based pulmonary rehabilitation, the routine practice when managing dyspnoea.

In the emotional function category, which measured how the participants were coping emotionally with their breathing conditions, it followed a similar pattern to the dyspnoea category. The highest possible total for the emotional function category is 49 and once again the higher the score the better the user feels about his emotional function. There was no statistical difference at baseline between the centre-based pulmonary rehabilitation and home-based pulmonary rehabilitation groups, with $t = -1.412$, $p > 0.05$, hence both groups were similar in emotional function at baseline. The centre-based pulmonary rehabilitation participants did have a slightly better emotional function, with a higher mean scores at both the start and the end of the programme (32.7 vs. 30.1; 37.2 vs. 34.3), when compared to the home-based pulmonary rehabilitation group. At the conclusion of the programmes, the mean value in both groups suggested a clinically significant improvement with no statistical difference between the two groups with $t = -0.044$, $p > 0.05$, as illustrated in Figure 19.

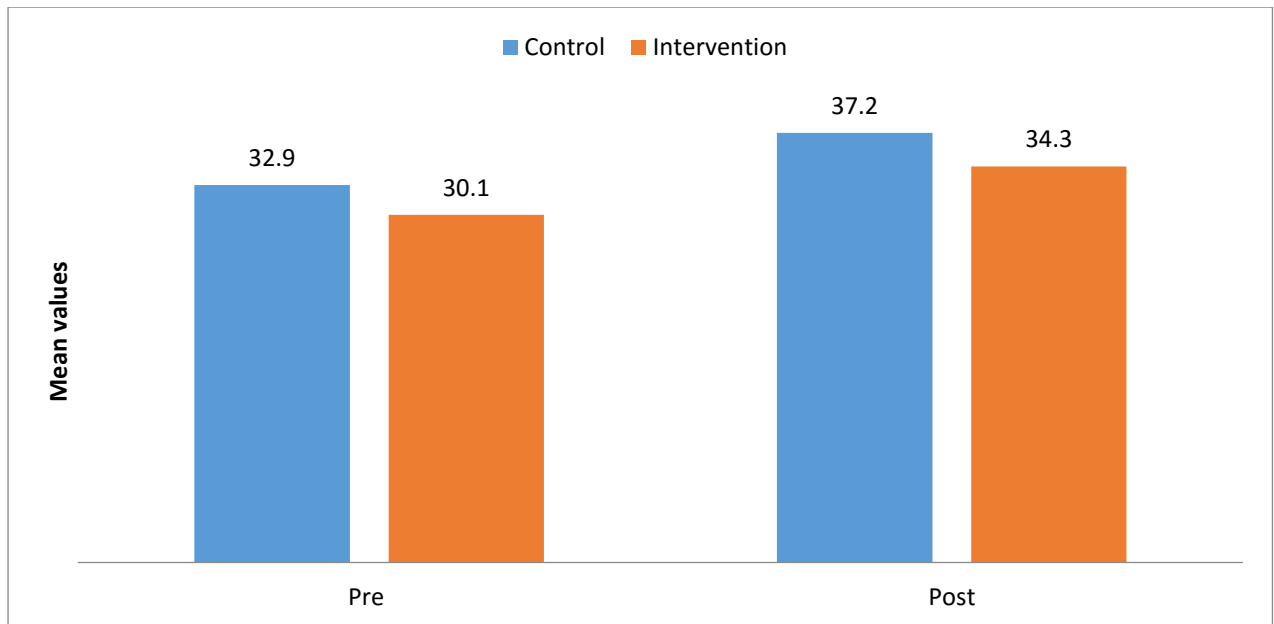


Figure 19. The CRQ emotional function mean values pre and post programme in the Control and Intervention groups.

The mean change difference values for the emotional function were calculated and analysed using the SPSS tool for both groups. The mean change difference values were then put through the parametric *t*-test the non-parametric Mann-Whitney and Wilcoxon statistical analysis to determine if there were any significance between the change in the centre-based pulmonary rehabilitation group and the home-based pulmonary rehabilitation group. In the centre-based pulmonary rehabilitation, the emotional function mean change value was 4.31 (ranged from -10 to 25) and in the home-based pulmonary rehabilitation, the mean change value was 4.23 (ranged from -17 to 16). Similar to the dyspnoea category, both analyses showed no statistical significant difference ($t = -0.044$, $p < 0.05$) between the centre-based pulmonary rehabilitation and the home-based pulmonary rehabilitation groups. There were clinically significant improvements in the emotional function category for both groups, and paired *t* testing also revealed both groups had achieved statistically significant improvement with centre-based pulmonary rehabilitation $t = -5.260$, $p < 0.05$ and home-based pulmonary rehabilitation $t = -2.104$, $p < 0.05$. The centre-based pulmonary rehabilitation group was able

to increase the emotional function value by 4.3 points whereas the home-based pulmonary rehabilitation 4.2 points. By taking into account that a clinical important difference was defined as 2 points, the centre-based pulmonary rehabilitation group performed better by 0.1 point, but the actual clinical importance would be insignificant. This result also suggests that the home-based pulmonary rehabilitation was no worse than the control, centre-based programmes when managing participants' emotional function.

In the mastery category, which measured how much the participants felt they were in control of their breathing conditions, there were similar trends to the previous two categories. The SPSS analysis did not suggest any statistical difference at baseline between the centre-based pulmonary rehabilitation and home-based pulmonary rehabilitation groups with $t = -0.297$ and $p > 0.05$. The centre-based pulmonary rehabilitation group appeared to have slightly more confidence in managing their own breathing condition at baseline, but one could argue that the 0.4 point difference in the mean value was minimal, considering 0.4 point is only 20% of the clinically important level of 2 points. Both groups appeared to have low mastery levels to their breathing conditions at baseline which was expected for this patient group. At the conclusion of the programmes, both groups' mean values were able to achieve clinically significant improved outcomes with no statistically significant difference between the two groups. The paired t tests showed the improvement made by both the centre-based pulmonary rehabilitation and home-based pulmonary rehabilitation groups were statistically significant, centre-based pulmonary rehabilitation $t = -5.560$, $p < 0.05$ and home-based pulmonary rehabilitation $t = -3.311$, $p < 0.05$. The highest possible score for the mastery category is 28, as illustrated in Figure 20.

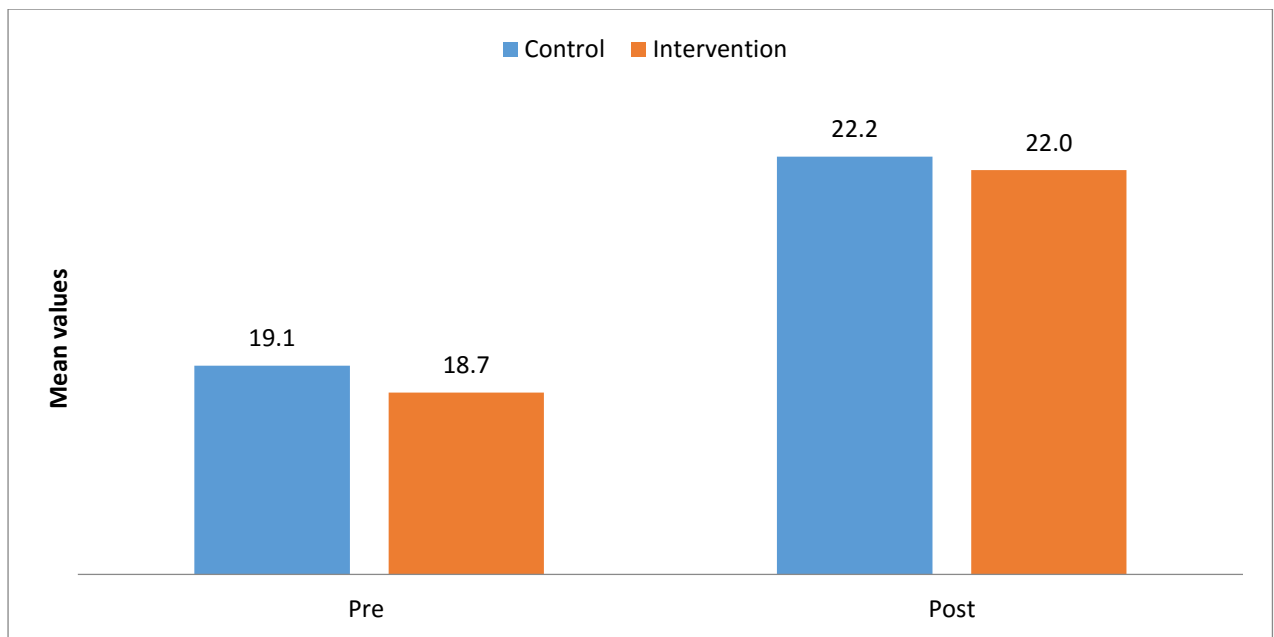


Figure 20. The CRQ mastery mean values pre and post programme in the Control and Intervention groups.

The mean change difference values were calculated using the SPSS statistics software for both groups. The mean change difference values were then put through the parametric *t*-test and the non-parametric Mann-Whitney and Wilcoxon statistical analysis to determine if there were any significance between the change in the centre-based pulmonary rehabilitation group and the home-based pulmonary rehabilitation groups. In the centre-based pulmonary rehabilitation the mastery mean change value was 3.07 (ranged from -9 to 12) and in the home-based pulmonary rehabilitation the mean change value was 3.24 (ranged from -4 to 13). Similar to the dyspnoea and emotional function categories, both analyses showed no statistically significant difference ($t = 0.146, p > 0.05$) between the centre-based pulmonary rehabilitation and the home-based pulmonary rehabilitation groups. This result indicates that the home-based pulmonary rehabilitation intervention was as effective as the centre-based pulmonary rehabilitation programme in improving participants' mastery level in managing their own breathing conditions.

The Fatigue category measures the amount of tiredness the participants felt that their breathing condition was affecting their lives in general with a highest possible total score being 28 representing the participant felt they had complete control over their level of fatigue. The baseline measurement revealed that both groups were comparable, with $t = -1.727$, $p > 0.05$. Once again the fatigue level in the centre-based pulmonary rehabilitation group appeared to have clinically significant better fatigue management at baseline when compared to the participants in the home-based pulmonary rehabilitation group, with a difference of 2.1 points (15.8 vs. 13.7). The mean values suggested that participants in both groups were able to achieve improvement in this category, which are results that are similar to the other CRQ categories. The centre-based pulmonary rehabilitation had made a 3.1 point clinically significant improvement and the home-based pulmonary rehabilitation group had made an improvement of 1.7 points, 0.3 points below the 2-point change required to achieve the clinically significant level. The statistical analysis confirmed the clinical interpretation with the centre-based pulmonary rehabilitation group and showed statistically significant improvement $t = -5.647$ $p < 0.05$, but not in the home-based pulmonary rehabilitation group with $t = -1.503$ $p > 0.05$. In terms of fatigue, the centre-based group performed better than the home based group, hence where fatigue is an important factor in a patient's self-management of COPD, providing and encouraging the participation in the centre-based pulmonary rehabilitation is preferable than providing the home-based pulmonary rehabilitation option, although the home-based pulmonary rehabilitation group were on average more fatigued at baseline compared to the centre-based pulmonary rehabilitation group, as illustrated in Figure 21.

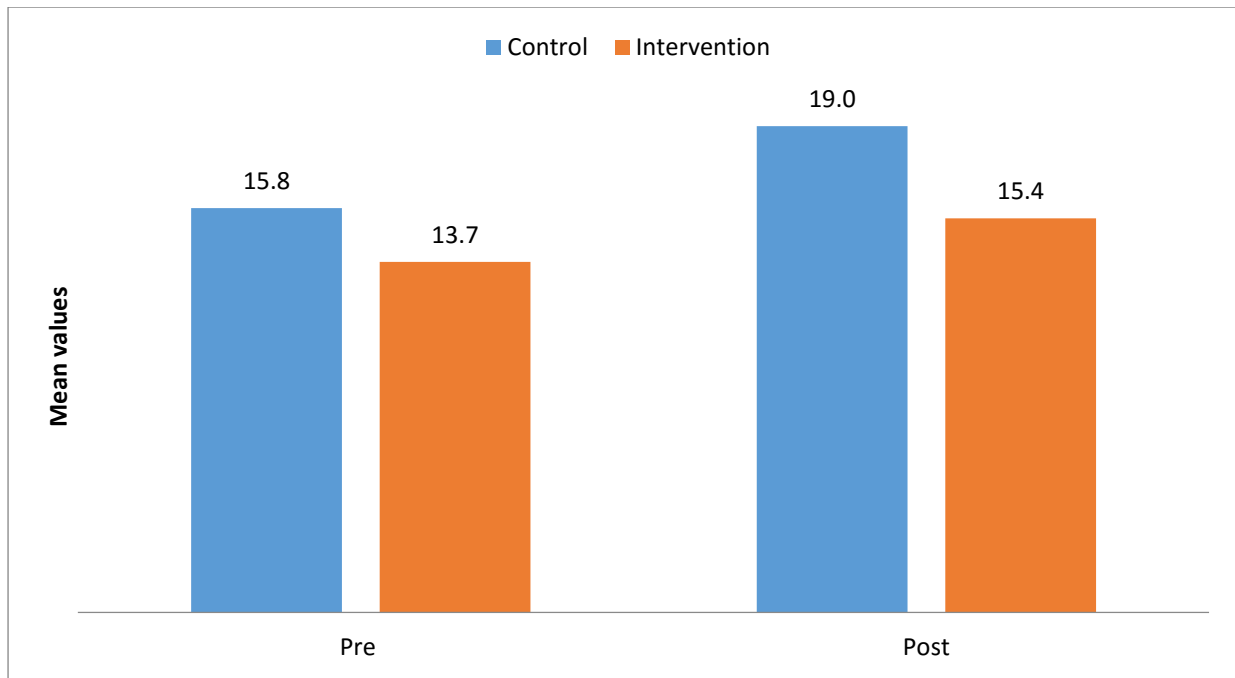


Figure 21. The CRQ fatigue mean values pre and post programme in the Control and Intervention groups.

The mean change difference values were calculated and analysed using the SPSS tool for both groups. The mean change difference values were then put through the parametric *t*-test and the non-parametric Mann-Whitney and Wilcoxon statistical analysis to determine if there were any statistical significance between the change in the control group and the intervention group. In the centre-based pulmonary rehabilitation the fatigue mean change value was calculated to be 3.04 (ranged from -7 to 15) and in the home-based pulmonary rehabilitation the mean change value was 1.66 (ranged from -8 to 10). This is similar to the other CRQ categories, where neither of the analyses showed any statistically significant difference, $t=-.195, p<0.05$, between the centre-based pulmonary rehabilitation and the home-based pulmonary rehabilitation groups in the fatigue mean change values. This result indicates that the home-based pulmonary rehabilitation was as equally effective in assisting participants to achieve positive change in the fatigue management category when compared to the centre-based pulmonary rehabilitation programmes. The centre-based programme was able to yield a

more superior statistically and clinically significant improvement when compared to the home-based pulmonary rehabilitation programme.

The secondary outcome measures:

The HADS results

Hospital Anxiety and Depression Score (HADS) is used to monitor and assess the mental wellbeing of the patients. This is a very widely used assessment tool in research worldwide when looking into the anxiety and depression levels of the patients. Lou et al. note that people living with chronic medical conditions have higher anxiety and depression levels compared to a healthy population (2012). The Chapter on methods provides a more detailed explanation of the HADS.

In both the home-based pulmonary rehabilitation and the centre-based pulmonary rehabilitation groups, the mean values before the programmes started were similar. The independent *t*-test indicates that at baseline, there were no statistical differences between the centre-based pulmonary rehabilitation and home-based pulmonary rehabilitation groups in their mean anxiety and depression levels. In the anxiety domain, $t = 0.287$, $p > 0.05$ and in the depression domain, $t = 0.842$, $p > 0.05$. In the centre-based pulmonary rehabilitation group, on average, patients had an anxiety score of 6.7 out of a total highest possible value of 21 and a depression score of 5 out of a highest possible total of 21. In both domains, the higher the score, the worse the symptoms would be. These values are compared to an anxiety mean value of 7, a 0.3 point difference, and a depression value of 5.6, a 0.6 point difference, in the home-based pulmonary rehabilitation group. In other words, at baseline, both groups had similar anxiety and depression values, as is illustrated in Figure 22.

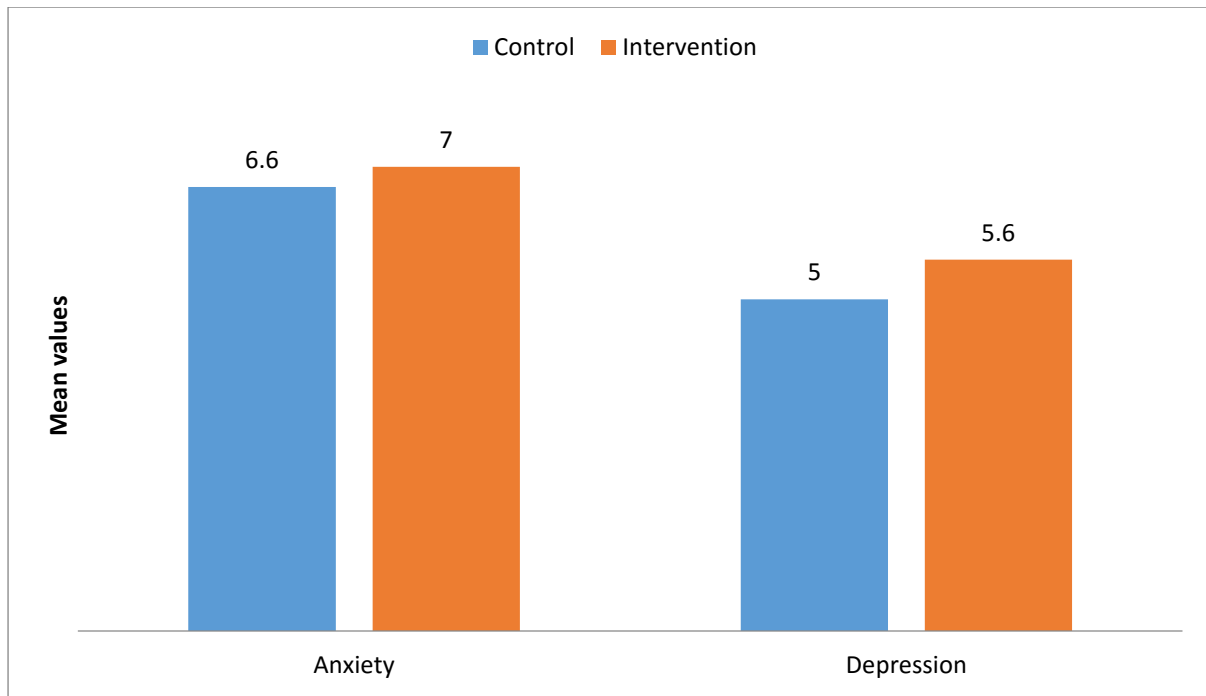


Figure 22. The HADS Pre Programme mean values in the Control and Intervention groups.

The HADS was measured again in both groups at the conclusion of the eight-week programmes. In the centre-based pulmonary rehabilitation group, the mean value for anxiety was 5.5 and for depression was 3.7. For the home-based pulmonary rehabilitation group, 6.7 was the mean value for the anxiety component and 5 for the depression component. No statistical differences were identified between the two groups on conclusion of the programmes with $t = 1.646$, $p > 0.05$ in the anxiety domain and $t = 1.897$, $p > 0.05$ in the depression domain, as illustrated in Figure 23.

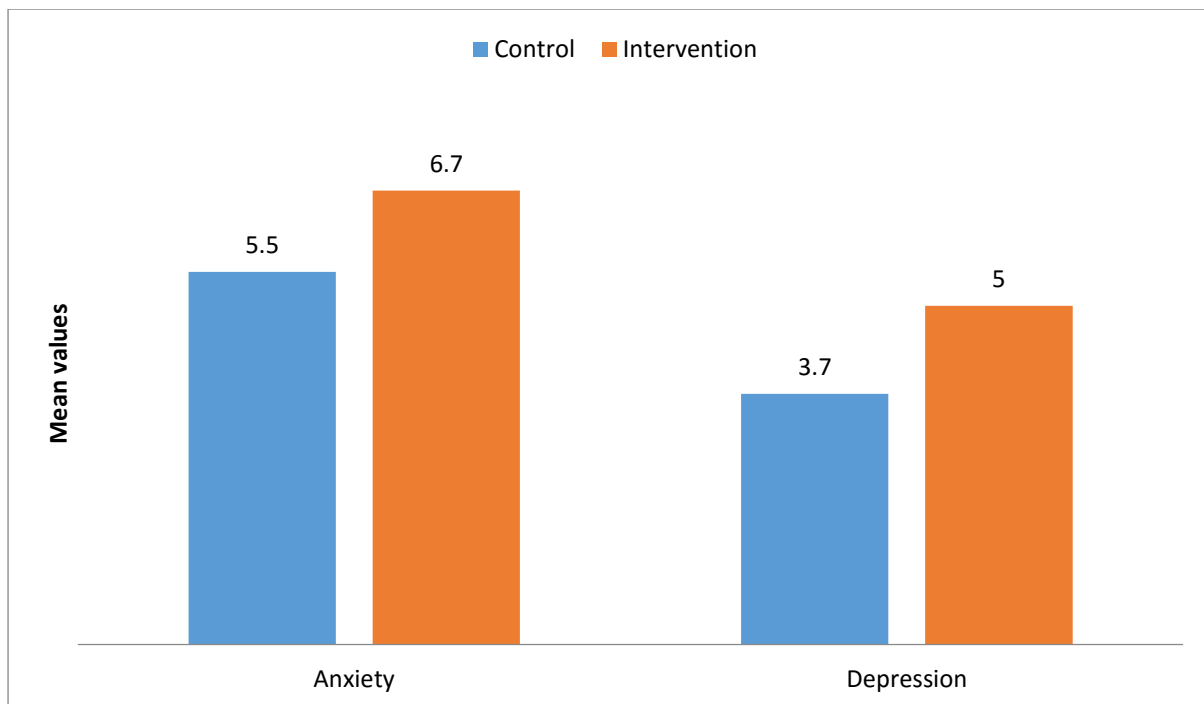


Figure 23. The HADS Post Programme mean values in the Control and Intervention groups.

The 2-tailed *t*-test was used as the main parametric analysis tool to examine the differences between the post-programme scores and pre-programmes scores. For the non-parametric analysis, a 2-tailed significance value was generated using the Mann-Whitney and Wilcoxon tests. Both parametric and non-parametric tests were used based on the results of the normal distribution analysis, which suggested the centre-based pulmonary rehabilitation group depression values were not following a normal univariate pattern. The analysis also had indicated that the difference between the post-programme and pre-programme anxiety values in the intervention group may not follow a normal univariate distribution.

Both the parametric and non-parametric analyses showed the mean change difference scores between the home-based pulmonary rehabilitation and centre-based pulmonary rehabilitation groups were not statistically significant, $t = -1.250$, $p > 0.05$ in the anxiety domain with centre-based pulmonary rehabilitation mean change value of 1.10 (ranged from -5 to 14) and home-based pulmonary rehabilitation mean change value of 0.24 (ranged from -4 to 8); and t

= -1.1.60, $p > 0.05$ in the depression domain with centre-based pulmonary rehabilitation mean change value of 1.25 (ranged from -4 to 7) and home-based pulmonary rehabilitation mean change value of 0.52 (ranged from -5 to 6). The before and after paired t -test for the centre-based pulmonary rehabilitation group indicated a statistically significant improvement in both the anxiety and depression domains, $t = 3.276$, $p < 0.05$ and $t = 4.172$, $p < 0.05$ respectively. The home-based pulmonary rehabilitation pre and post HADS outcomes were not statistically significant, for the anxiety domain ($t = 0.404$, $p > 0.05$) or in the depression domain ($t = 0.937$, $p > 0.05$), and therefore there were no clinical improvements in these domains for the CBRP group. These outcomes illustrated that both home-based pulmonary rehabilitation and the centre-based pulmonary rehabilitation group, for managing anxiety and depression levels in people living with COPD, achieved change in the expected direction. In the centre-based pulmonary rehabilitation group, however, the change was greater than that experienced in the home-based pulmonary rehabilitation group.

The 1-minute sit-to-stand test

As mentioned in the chapter on methods, the 1-minute sit-to-stand test (1MSTST) is a fast and practical test to assess a participant's exercise capacity. The pulmonary rehabilitation service only started to use this exercise capacity test recently, and therefore, I was unable to obtain any 1MSTST historical data for the home-based pulmonary rehabilitation (control) group to compare to the HBRP group in this category. Altogether there were 19 completed 1MSTST data sets from the home-based pulmonary rehabilitation group, which included a pre-programme and a post-programme score. Radtke et al. (2016) states that the test has an estimated minimal detectable difference value of 5 in 1MSTST for the cystic fibrosis population. Simm et al. (2014) used a minimal detectable change value of 4 in 1MSTST for the participants in the pain management programme. For the purpose of this study, a change value of 5 is the minimal detectable difference value (clinically significance change), because

the people who attend the pulmonary rehabilitation programmes would have more resemblance symptomatically to people living with cystic fibrosis than people living with chronic pain.

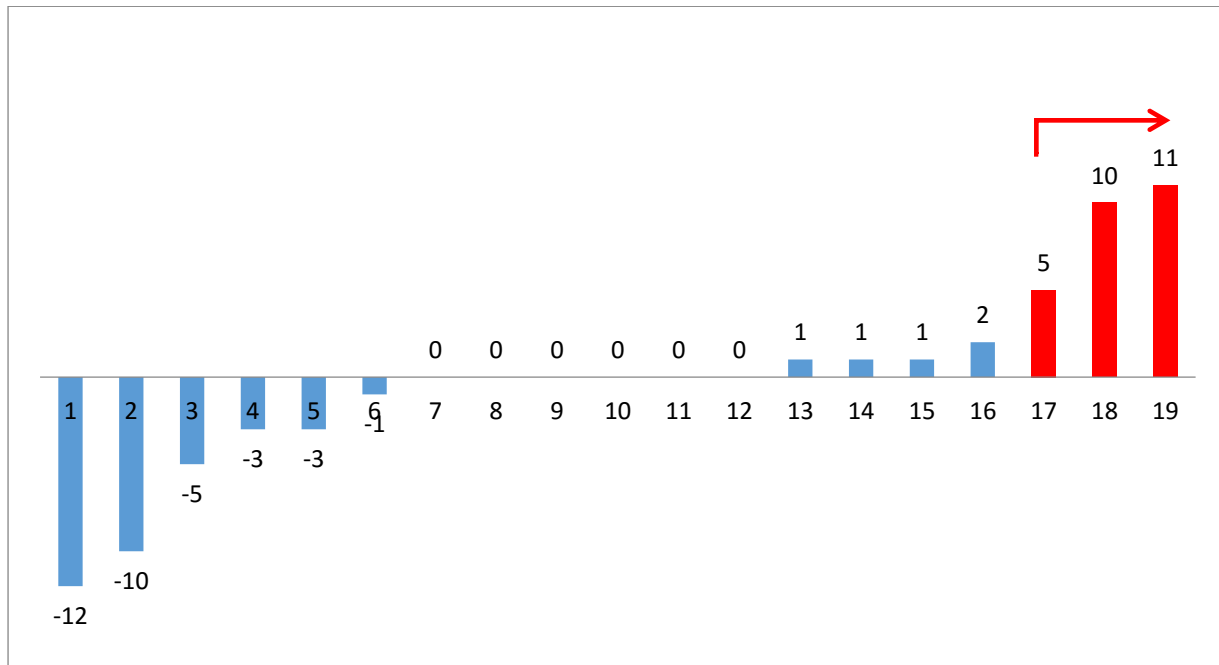


Figure 24. The 1MSTST change values for the intervention group.

Only three out of the 19 participants (16%) had achieved a detectable change in the 1MSTST, as illustrated in Figure 24. The participants in the intervention group had a mean 1MSTST score of 18.3 at the beginning of the programme and 18.1 at the conclusion of the programme with a mean change statistical significant difference between the pre-programme and post-programme outcome of -0.2 repetition. The paired *t*-test also showed that there was no values, with $t = 0.664$, $p > 0.05$. These statistics were compared to the draft year 2013-2015 Pulmonary Rehabilitation Outcome Report (CCN Community Pulmonary Rehabilitation Services, 2015). In the community pulmonary rehabilitation programmes, the report described 36% of the 152 participants had achieved a detectable change with the mean pre-programme 1MSTST score of 17.8 and 20.4 at the conclusion of the programme, a mean change of 2.5 repetitions. The statistics appeared to suggest that the centre-based pulmonary

rehabilitation programmes were better in improving participants' fitness level, although the patients in the report may have differed from other aspects from the patients in the HBRP, hence more research is required to replicate this result.

The COPD assessment tool (CAT) score

The CAT score is an 8-statement based questionnaire. As mentioned in the chapter on methods, the CAT score is a practical way to measure the impact of COPD on the participant's wellbeing in general. This is a useful tool for the participant and the health professional to determine whether there is a need to implement extra strategies to maximise the effect of the medical treatments and self-management plans (Jones et al., 2009). Like the 1MSTST this assessment tool had only recently been introduced to the pulmonary rehabilitation service and I was unable to obtain historical data for the home-based pulmonary rehabilitation group to compare to.

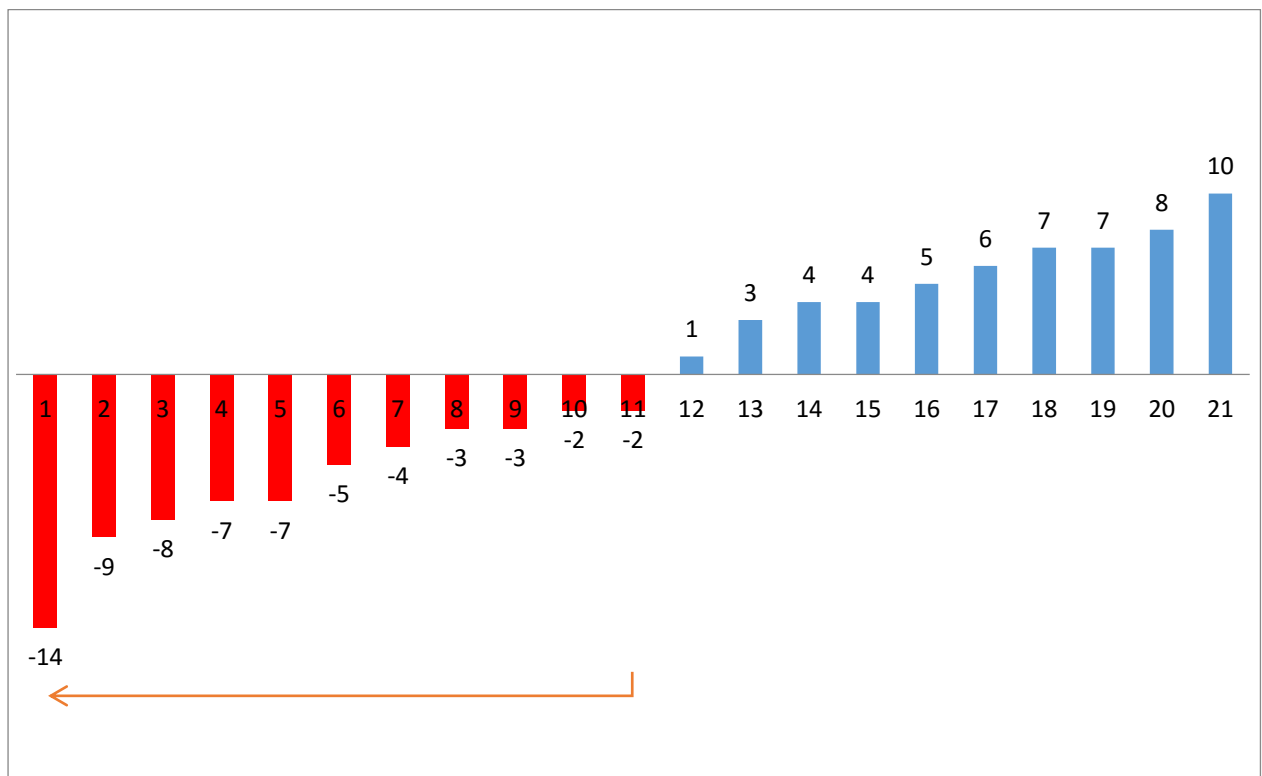


Figure 25. The CAT score change values for the intervention group.

There were 21 participants who had completed the pre-programme and post-programme CAT scores. Eleven out of 21 participants (52%) achieved a clinically significant improvement, as illustrated in Figure 25. The mean baseline value was 19.7 and the mean post-intervention score was 19.2 with a mean change of -0.4 shared among the 21 participants. Despite the

majority of the home-based pulmonary rehabilitation group having achieved a clinically significant improvement, the pre-programme and post-programme home-based pulmonary rehabilitation CAT score values were unable to achieve statistical significant improvement when analysed using paired *t*-test, $t = 0.298$, $p > 0.05$. These statistics were compared to the draft year 2013-2015 pulmonary rehabilitation outcome report (CCN Community Pulmonary Rehabilitation Services, 2015). In the community pulmonary rehabilitation programmes report 48% of the 191 participants had achieved a clinically significant change with the mean pre-programme CAT score of 19.3 and 18.1 at the conclusion of the programme, a mean change of -1.1 to the score. At a glance, both the home-based pulmonary rehabilitation and centre-based pulmonary rehabilitation were as effective in supporting the participants to achieve a clinically significant improvement, although for the HBRP group this improvement was not statistically significant.

EQ-5D

The EuroQol Group's 5-dimension questionnaire (EQ-5D), described in the Chapter on methods, is a commonly used questionnaire internationally to measure health-related quality of life (HRQOL) (Zanini et al, 2015). Unfortunately, the historical EQ-5D data set for the centre-based group was incomplete. The database only recorded the overall EQ-5D index score not the individual domain scores, which would be required for detailed analysis. For this study, therefore, I will look at the overall EQ-5D index, EQ-5D visual analogue scale (VAS) and the comparison between the two groups to get some understanding of the changes made in participants' quality of life. Zanini et al. (2015) suggested for the moderate-to-severe COPD participant a change of 8 units or greater on the EQ-5D VAS (equivalent to 0.8 and greater in this study) to be the minimal clinically important difference. For the EQ-5D index, Pickard et al. (2008) reported reference values for the people living with COPD according to the different stages of COPD.

In the intervention group, 13 out of the 21 participants (62%) had made a positive shift in their EQ-5D indices compared to 35 out of 68 participants (51%) in the centre based control group. The mean baseline EQ-5D indices for the intervention and control groups were 0.59 and 0.62 respectively. These values were compared to the pooled mean utility reference values suggested by Pickard et al. (2008). The mean forced expiratory volume during the first second (FEV1) values from both groups (45% for the control and 41% for the intervention group) indicated that the participants had severe air obstruction or Stage III COPD (FEV1 value between 30-50%). Stage III COPD has an EQ-5D pooled mean utility reference value of 0.69 (0.60-0.78) (Pickard et al, 2008). This indicated, before the participants started the pulmonary programme, that the quality of life index for participants in the intervention group was below the reference range and pooled mean value. The mean for the participants in the control group was just within the reference range but below the mean utility reference value for Stage III COPD population. The values were corrected once the participants completed the programme. In the home-based pulmonary rehabilitation group the mean value was improved to 0.64 and 0.68 for the centre based group. This indicates that participation in both groups was effective in elevating the participant's quality of life level, noting that the control group index was almost reaching the mean utility value, as illustrated in Figures 26 and 27.

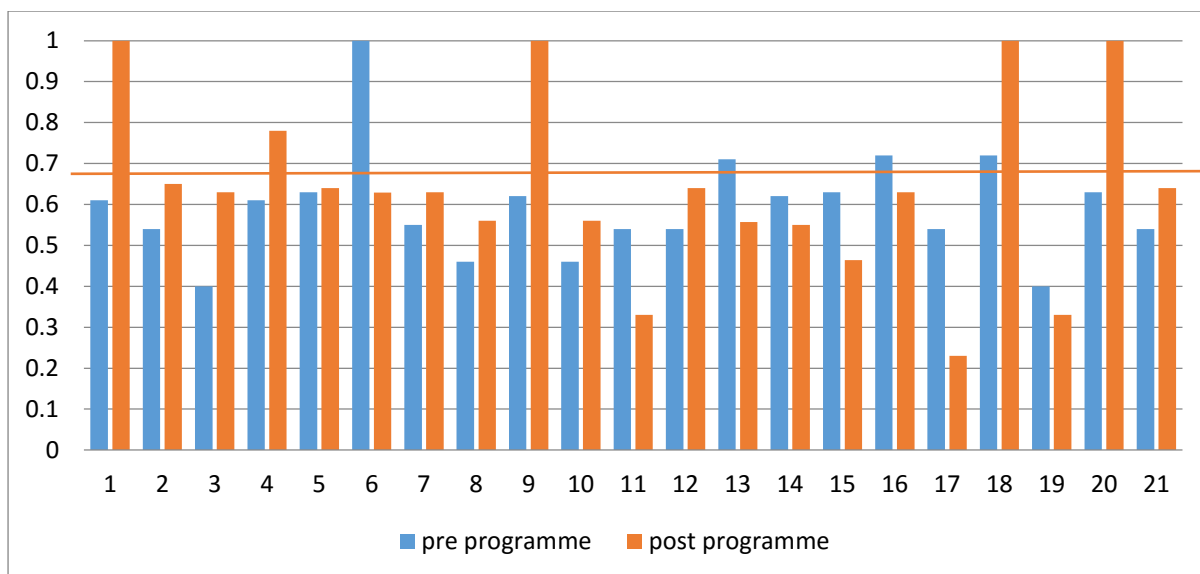


Figure 26. The Pre and post EQ-5D index values for the intervention group

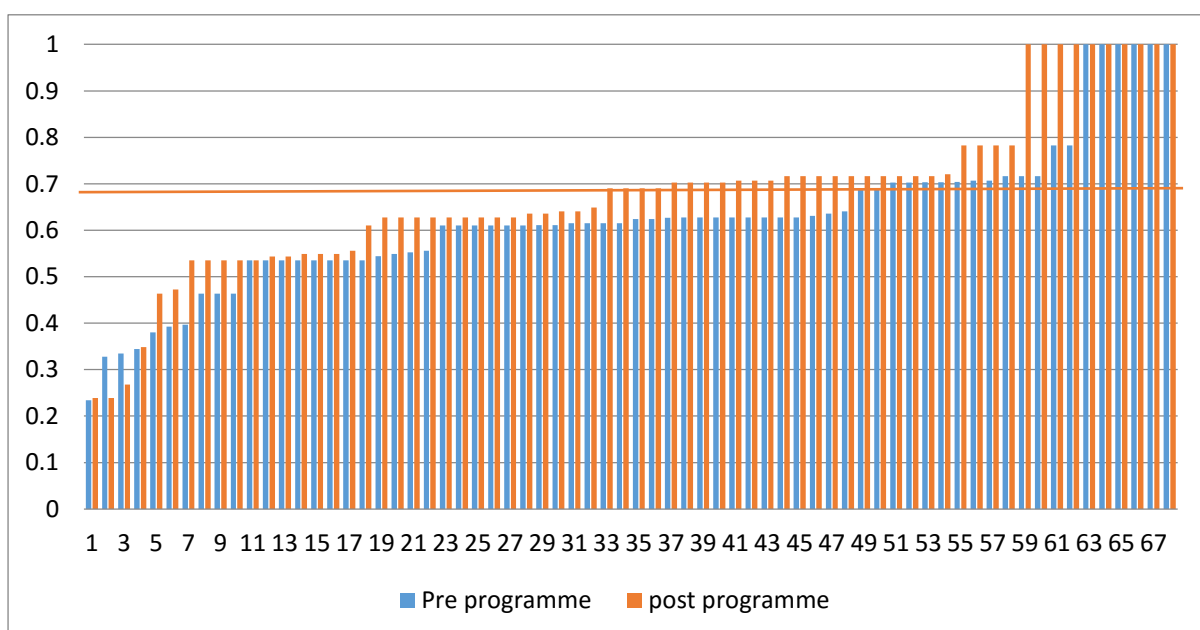


Figure 27. The Pre and post EQ-5D index values for the control group

The EQ-5D VAS also presented similar trends in both the intervention and control groups.

Ten out of the 20 participants (50%) in the intervention group and 33 out of 61 (54%) were able to make a positive shift on the VAS. The control group had a mean baseline VAS value of 5.85 compared to 6.67 in the intervention group. On completion of the programmes, the

control group had an improved mean VAS value of 6.2 compared to 7.33 in the intervention group, and a mean change value of 0.35 and 0.66 for the control and intervention groups, respectively. The mean change values were below the Zanini et al. (2015) estimated and recommended minimal clinically important difference of 0.8 points. After attending the programme, however, the majority of the participants felt their quality of life had either been maintained or improved. It was encouraging to know that 8 (40%) participants in the intervention group and 26 (42%) in the control group had achieved the minimal clinically important difference threshold. Statistical analysis revealed the centre-based pulmonary rehabilitation group was able to achieve significant improvement in both the index ($t = -3.021, p < 0.05$) and VAS ($t = -2.908, p < 0.05$) domains. Unfortunately, the same was not able to be replicated in the home-based pulmonary rehabilitation group with the EQ-5D index ($t = -0.979, p > 0.05$ and VAS $t = -0.746, p > 0.05$). These results are illustrated in Figures 28 and 30.

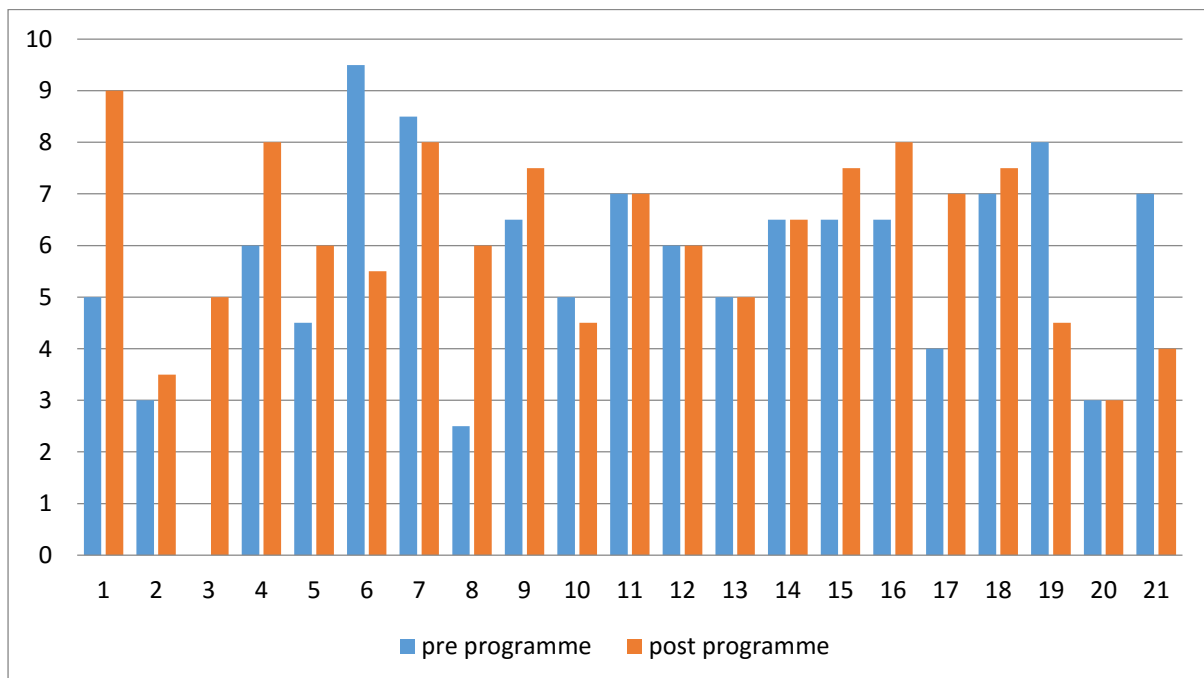


Figure 28. The Pre and post EQ-5D VAS values for the intervention group.

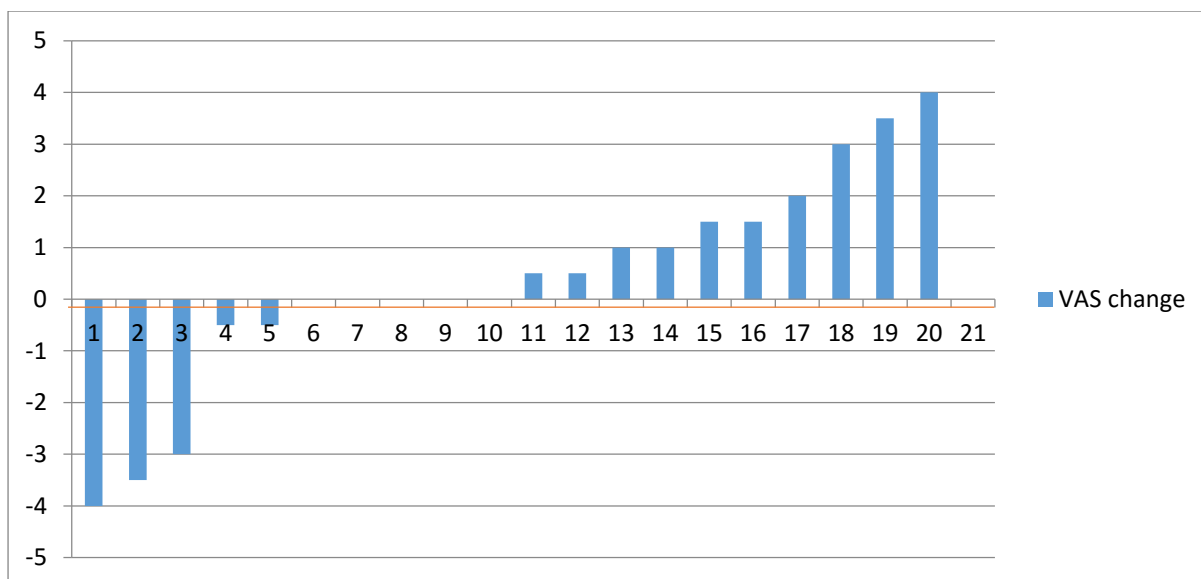


Figure 29. The EQ-5D VAS change values for the intervention group.

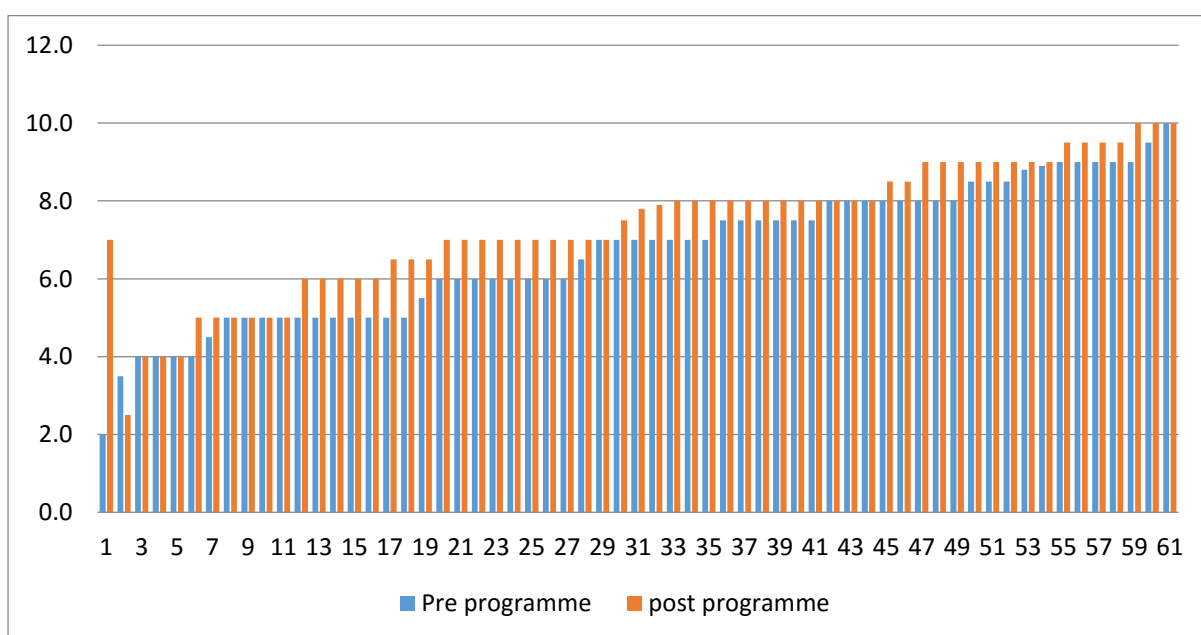


Figure 30. The Pre and post EQ-5D VAS values for the control group.

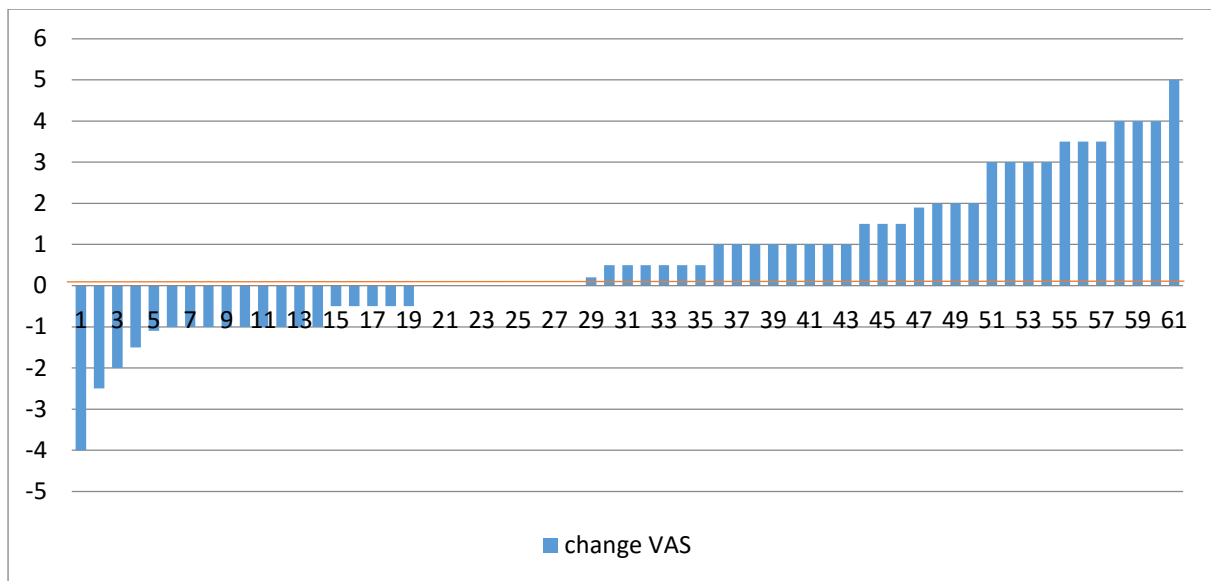


Figure 31. The EQ-5D VAS change values for the control group.

The change values between the centre-based pulmonary rehabilitation and the home-based pulmonary rehabilitation group were analysed using SPSS. The tests revealed that there was no statistically significant difference between the two groups. In the EQ-5D index the centre-based pulmonary rehabilitation had a mean change value of 0.05 (ranged from -0.3 to 0.39) and home-based pulmonary rehabilitation mean change value of 0.05 (ranged from -0.37 to 0.39) with a calculated $t = -0.196$, $p > 0.05$; $z = -0.180$, $p > 0.05$. The centre-based pulmonary rehabilitation EQ-5D VAS had a mean change value of 1.02 (ranged from -4 to 10) and home-based pulmonary rehabilitation mean change value of 0.57 (ranged from -4 to 5) with a calculated $t = -0.786$, $p = 0.05$; $z = -0.227$, $p > 0.05$. Both the parametric and non-parametric tests were carried out due to the fact that not all results collected from the EQ-5D had a univariant distribution. In summary the results suggested that the intervention group, the home-based pulmonary rehabilitation, performed no worse than the control (centre-based) pulmonary rehabilitation when improving the participant's quality of life, as illustrated in Figures 29 and 31.

Summary of results:

- CRQ dyspnoea: the home-based pulmonary rehabilitation group was no worse than the control (centre-based) group.
- CRQ emotional function: the home-based pulmonary rehabilitation group was no worse than the control group.
- CRQ mastery: the home-based pulmonary rehabilitation group was no worse than the control group
- CRQ fatigue: the home-based pulmonary rehabilitation groups was no worse in making clinically significant improvement when compared to the control group; however the control group had a significantly superior fitness level or fatigue management on post-assessment when compare to the home-based pulmonary rehabilitation group
- HADS: home-based pulmonary rehabilitation provided anxiety and depression management which was statistically no worse than the control group.
- 1MSTST: The control group appeared to do better at improving the participants' level of fitness when compared to the home-based pulmonary rehabilitation group.
- CATS: the home-based pulmonary rehabilitation appeared to be no worse in helping the participants to learn how to effectively manage their breathing conditions when compared to the control group.
- EQ-5D: the home-based pulmonary rehabilitation appeared to be no worse in improving participant's quality of life; however, the centre-based pulmonary rehabilitation group had achieved significantly better outcomes when compared to the home-based pulmonary rehabilitation group.

The next chapter discuss the results presented in this chapter with reference to the study objectives and hypotheses. I also explore further the results in this study with current literature and current clinical practice.

Chapter 5: Discussion

Introduction

Pulmonary rehabilitation is the back bone to this thesis and a well evidence-based practice to treat people living with chronic respiratory illnesses. In the literature review the research evidence had suggested that pulmonary rehabilitation is effective in improving patients' self-management skills by improving their breathing patterns, exercise capacity, and reducing the social isolation the chronic illnesses created. The home-based pulmonary rehabilitation was instigated due to the low referral and low completion rates within the centre-based pulmonary rehabilitation programme in the Canterbury region. This thesis examined the hypotheses that the home-based pulmonary rehabilitation would perform no worse than the centre-based pulmonary rehabilitation in the CRQ category and result in an objective improvement in the sit-to-stand test that is no worse than the centre-based pulmonary rehabilitation. The data analysis has confirmed that the home-based pulmonary rehabilitation is no worse than the centre-based pulmonary rehabilitation in all categories of the CRQ in achieving improvements; however, the home-based pulmonary rehabilitation was unable to outperform the centre-based pulmonary rehabilitation in the sit-to-stand test, and the exercise capacity test. These findings and conclusions must be interpreted with the project's limitations and context in mind.

The thesis findings are appraised with reference to current literature and evidence. The applications and implications of these research findings are multifaceted. The findings are approached from the patient journey perspective, looking at the objective measures and determine whether the home-based pulmonary rehabilitation was able to generate the hypothesised effects to these people living with chronic respiratory conditions at home. The findings are also examined from the providers' perspective: a change of delivery model, the time and costs invested into this new model of delivery, and whether it is sustainable and economical to have home-based pulmonary rehabilitation as a permanent option within the

community pulmonary rehabilitation services. Lastly, the findings are also be assessed from the broader health system angle: is there a demand for such a home-based alternative?

At this point, it is important to remember that the participants in the home-based pulmonary rehabilitation had already refused or declined offers to participate in the centre-based pulmonary rehabilitation programmes. If the home-based pulmonary rehabilitation programme were not put in place and offered to this group of participants, they would not be involved in any pulmonary rehabilitation services. In other words, the centre-based approach has already failed for the cohort of participants who were part of this home-based programme, and therefore the playing field is already not even. The consequences of such disconnect from health services could lead to a poorer quality of life and worse health outcomes.

Overview

The home-based pulmonary rehabilitation was able to deliver an effective intervention to people living with COPD. The majority of the outcome measures used in the study had shown the effects of home-based pulmonary rehabilitation were no worse than the centre-based pulmonary rehabilitation, except for the CRQ fatigue and EQ-5D scores where home-based pulmonary rehabilitation participants performed worse when compared to the centre-based pulmonary rehabilitation participants. Overall, the home-based pulmonary rehabilitation was more accessible and equitable to the Canterbury COPD community.

Demographics

The demographic analyses identified some interesting findings with regards to patient participation in pulmonary rehabilitation programmes. First, the analysis suggested the home-based pulmonary rehabilitation was better at retaining male participants. In the home-based pulmonary rehabilitation group, we had a male to female participant ratio of roughly 1:1 (52% and 48%), compared to 34% of male participants to 66% female participants in the control group centre-based pulmonary rehabilitation, which is about 1:2 in ratio. This interpretation must be viewed with the following considerations in mind. In 2013, the community pulmonary rehabilitation data was fully moved to an electronic system, MedTech. To date (December 2016), of all the referrals with gender status clearly stated, there is a total of 2,248 referrals received in the last three years, inclusive of the home-based pulmonary rehabilitation referrals (Canterbury Clinical Network, December 2016). The data indicated 56% of the referrals were females and 44% were males. Puhan et al. (2005), carried out a systemic review on the effects of pulmonary rehabilitation on hospital admission and mortality to people with acute exacerbation of COPD. The randomised controlled trials included had mostly shown a male-dominant (five out of six studies) phenomenon, ranging from 41% to 90% male participants.

The latest 2013 New Zealand Census (Statistics New Zealand, 2016) indicated the total population in the Canterbury region was 539,436, with 266,349 males and 273,087 females. These values equate to 49% of the Canterbury population were males and 51% were females. In other words, the centre-based pulmonary rehabilitation male and female gender distribution appeared to be in line with the referral trends but did not reflect the actual gender profile in the Canterbury region, where there are about equal proportion between the genders. Until recently the World Health Organisation (WHO) identified COPD as affecting more men than women; however, with the recent increase in tobacco use among women in high income

countries and more frequent exposure to other high risk contaminants among women, the disease is now affecting men and women in an almost equal proportion (WHO, 2016). The home-based pulmonary rehabilitation appeared to have the ability to correct the male to female referral imbalance, to reach out to an almost equal representation from the both genders, or in other words, to attract males to the home-based pulmonary rehabilitation, who refused invitation to attend the centre-based pulmonary rehabilitation.

The male health utilisation pattern should also be considered in the interpretations of the lower male pulmonary rehabilitation referral and pulmonary rehabilitation attendance rates. Misan (2013) mentioned in his document that males were 15% less likely to visit a GP when compared to their female counterpart in a 12-month period (Misan, 2013). Britt et al. (2012) in their data on general practice activity in Australia between the years 2011 to 2012 also commented on lower health service utilisation in the male population. The report indicated that during the 12-month period, there were 43,000 GP encounters with males, which accounted for only 43% of the total GP consultations (Britt et al., 2012). Another paper by Schlichthorst et al. (2016), looking at factors associated with the healthcare utilisation by Australian men, found that the majority of men (61%) did not have regular health check-up visits in a 12-month period of time. The authors explained further the lack of regular primary health consultations may lead to lost opportunities in early detection and intervention for men, thus producing poorer health outcomes for men in general (Schlichthorst et al., 2016). The above findings would be of no surprise to the Canterbury pulmonary rehabilitation service providers. The pulmonary rehabilitation database (CCN, 2016) identifies that in 2015, the majority (59%) of the Canterbury pulmonary rehabilitation referrals were generated from the GP practices. If men are 15% less likely to go and see a GP and 61% of men did not have regular health check-ups, then assuming the target (Canterbury, New Zealand) male population has the same health utilisation rate as elsewhere suggests, we can infer that men

have missed out on being detected early and referred to the pulmonary rehabilitation service by as much as 61%. This can be one of the main explanations for the lack of male referrals and participants to the pulmonary rehabilitation services.

The second interesting finding from this research project was the mean age for people participating the intervention group (the home-based pulmonary rehabilitation) was significantly younger, by almost six years, when compared to the participants in the control group (the centre-based pulmonary rehabilitation). The data indicated that the mean age for the home-based pulmonary rehabilitation group was 68.76 years and for the centre-based pulmonary rehabilitation, the mean age was 74.61 years of age. In most of the international literature, the mean age range for the pulmonary rehabilitation participants was between 65 to 70 years of age (Schroff et al., 2017; Dodd et al., 2011; Eaton et al., 2009). In a recent paper by Schroff et al. (2017), the authors included 229 participants living with COPD who were enrolled in the pulmonary rehabilitation at the University of Alabama at Birmingham, U S from 1996 to 2013. The mean age was 66.5 years, 40% of the participants were females and with an overall mean FEV1 value of 46.3% predicted (Schroff et al., 2017). Dodd and colleagues (2011) had 297 data sets with a mean age of 69.2 years, 62.7% male and a mean FEV1 value of 50.9% predicted (Dodd et al., 2011). In another randomised controlled trial, conducted by Eaton et al. (2009), the authors had 97 COPD patients recruited from the greater Auckland region, New Zealand, with a mean age of 70 years, 44% male and a mean FEV1 of 36% predicted (Eaton et al., 2009).

The literature discussed above appears to suggest that the home-based pulmonary rehabilitation was potentially capturing the right age group but in the centre-based pulmonary rehabilitation, with a mean age of over 74 years appeared to be older than expected. Possible explanations for this finding include: there is a minor flaw in the control data set where in the pre database era (2009-2013), the patients' details were recorded on an Excel spreadsheet and

only the patient's date of birth was recorded, or the actual age when the patient attended the pulmonary rehabilitation was unable to be traced. To get an estimated age value and be consistent with the home-based pulmonary rehabilitation intervention group participants, both patient samples in this study had their age measured to November 2015. However, in a recent Canterbury pulmonary rehabilitation outcome measure report (CCN, 2016), of the total 214 participants, the report had suggested a mean age of 72.3 years which concurred to the thesis finding centre based pulmonary rehabilitation group. This appeared to be in supportive of the living better and older statement mentioned previously. Moreover, in New Zealand, many people stop working around the age of 65, because this is the age set for the New Zealanders to be qualified to receive the age-related Government-funded pension (New Zealand Government, 2016). Because the centre-based pulmonary rehabilitation has a greater commitment for the participants, a structured twice a week, two hours per session programme, the data appeared to be suggesting the centre-based pulmonary rehabilitation was better attended by people who were well into their retirement. In contrast, from my observation in my role as a pulmonary rehabilitation clinician carrying out the assessments, participants in the home-based pulmonary rehabilitation, may still have been working part-time or even full-time and may therefore not fully committed to a centre based rehabilitation programme. Other reasons, mentioned previously, which may prevent a patient participating in a pulmonary rehabilitation, include social stigma, being breathless in public, convenience, and transportation issues.

The third interesting finding in the demographic profile was that the New Zealand Māori participants appeared to be almost four times more likely to attend a home-based programme than a centre-based programme. In the home-based pulmonary rehabilitation group 14% of the participants identified themselves as New Zealand Māori, whereas in the centre-based pulmonary rehabilitation, only 4% did, which is an even more startling statistic when one

takes into consideration the national Māori population proportion at the latest 2013 New Zealand Census (2013) was 15% in total and about 8% in Canterbury (New Zealand Census, 2013). The census values suggest that the pulmonary rehabilitation service in Canterbury should have about 8% of Māori participants in the programme. In fact, the Home-based Programme attracted almost double the anticipated number (and just under the national percentage) and the Centre-based Pulmonary Rehabilitation Programme attracted only half the Canterbury percentage. Gracey and King (2009) estimate there are almost 400 million indigenous people in the world and a significant number of them live with in poor health standards. Regardless of the developmental status of the countries these indigenous people are native to, these peoples, whether they are living in Australia, New Zealand, United States of America or the United States-associated Micronesia, have higher rates of illness in cancer, cardiovascular, respiratory diseases, stroke, and diabetes (Anderson et al., 2006). The indigenous people around the globe are also faced with lower life expectancy at birth and higher infant mortality rates (Bramley et al., 2005). In New Zealand, Māori people living with COPD experience poorer health services and those who are living with a chronic lung condition, have longer and more frequent hospitalisations and more death associated with COPD when compared to the non-Māori community (Telfar et al., 2015). All the evidence indicates the importance of a more New Zealand Māori inclusive approach to health services.

In a recently published paper by Levack et al. (2016), the authors stated that, regardless of ethnicity, the common reasons for non-attendance at a pulmonary rehabilitation programme was the participant's previous experience in exercise or the health care system, the attitude and expectation of the people involved in the service, access issues, and the initial programme experience. These findings were consistent with the Ramage et al. (2016) findings where 75 people were surveyed, who were referred, but did not attend, a pulmonary rehabilitation session. Levack et al.'s 2016 explored further on these issues and revealed that

for the New Zealand Māori, whakawhanaungatanga (the making of culturally meaningful connections with others) was an important factor in determining the likelihood of a New Zealand Māori participant attending a programme or not. The culturally meaningful connections refer to practices, communication and relationship-building that are culturally sensitive or appropriate (Levack et al., 2016). For some Māori participants, they felt the absence of a holistic service would make them feel culturally unsafe, which would lead to lower attendance at the pulmonary rehabilitation programmes (Levack et al., 2016). This analysis suggests that the home-based pulmonary rehabilitation approach is a more culturally safe method, reduces equity differences, and is helpful for Māori, who live with chronic respiratory illnesses.

The last interesting demographic finding was in the participants' baseline severity of airflow obstruction shown in their spirometry results. The data showed that most of the participant values (close to 80% in both groups) were recorded between the *moderate* to *severe* categories of airflow obstruction; however, in the home-based pulmonary rehabilitation group, there is a sharp and obvious peak in the *severe* category. The home-based pulmonary rehabilitation group has more than 50% of the participants in the severe airflow obstruction category compared to 40% in the centre-based pulmonary rehabilitation programmes. The percentage of the predicted forced expiratory volume during the first second (FEV1), or known as the volume of air forced out in one second, was used to determine the severity of airflow obstruction in people living with COPD. The Global Initiative for Chronic Obstruction Lung Disease stated that the different severities are determined as follows: mild obstruction means the FEV1 is greater or equal to 80% of the predicted value; moderate obstruction means the FEV1 is less than 80% but greater or equal to 50% of the predicted value; severe airflow obstruction refers to an FEV1 value less than 50% but greater or equal to 30% of the predicted volume; and very severe airflow obstruction refers to a FEV1 volume

of less than 30% predicted (GOLD, 2015). Assuming that airflow obstruction is positively correlated to exercise capacity and functions in the researched Canterbury population, the home-based pulmonary rehabilitation was able to support more people living with severe COPD than the centre-based pulmonary rehabilitation. It can also mean that more people living with severely obstructed airway felt more comfortable to accept a pulmonary rehabilitation offer when they were assessed and treated at home. This interesting phenomenon may be explained by a simple example. In a typical pulmonary rehabilitation participant with severe airflow obstruction, the person would experience significant symptoms of breathlessness and fatigue, and as a result, a loss of function. In general, personal services, such as personal care for showering or bathing, domestic assistance for cleaning tasks inside the home, meals on wheels, would be put in place to support the person's living. Unfortunately, the Canterbury pulmonary rehabilitation service has only one time frame to run the programmes, which between the hours of 12:30 and 15:30, either on a Monday and Wednesday, or a Tuesday and Thursday combination. This means that the pulmonary rehabilitation service may be unable to provide enough flexibility to fit into the participant's living routine. Ramage et al. (2016) supported this viewpoint that the traditional pulmonary rehabilitation programme lacked flexibility from their study done on the reasons for non-attendance at the pulmonary rehabilitation service in Canterbury. The most frequently reported reason was disruption of usual routine (27.3%), followed by travel (18.2%), and fears or concerns about the programme (18.2%). For the home-based pulmonary rehabilitation, the timing was a lot more flexible when compared to the centre-based pulmonary rehabilitation. The participant was able to choose a one hour appointment session between the hours of 09:30 to 16:00 Monday to Friday. By having a home visit at a time that was convenient for the participant and they were comfortable with, removed the transportation barrier and reduced the level of anxiety and fear for participants with more

symptomatic breathing. This may be the reason why the more severely obstructed COPD participants were in the home-based pulmonary rehabilitation group: unable to attend the centre-based pulmonary rehabilitation due to not wanting to disrupt daily routines or concerns about personal safety outside the home due to breathing difficulties,.

Primary Outcomes

The CRQ was the primary outcome measure used to assess the difference between the home-based pulmonary rehabilitation and centre-based pulmonary rehabilitation groups. The CRQ measures four major components of a person living with a chronic respiratory condition: dyspnoea, emotional function, mastery, and fatigue. Each domain is discussed in more detail in the following paragraphs.

The study has shown the home-based pulmonary rehabilitation's performance in improving the participant's level of dyspnoea was not statistically significantly different from the centre-based pulmonary rehabilitation. Both groups were able to assist the participant to achieve clinically significant improvement in the dyspnoea component by the end of the eight-week programme. The mean baseline value for the home-based pulmonary rehabilitation in dyspnoea was 14.2 and it improved to 18.3. Dyspnoea more commonly known as breathlessness is most commonly caused by exercise (exertion)-induced oxygen desaturation. Jenkins and Cecins reported that in 47% of referred pulmonary rehabilitation participants their oxygen saturation would decrease to below 90% while doing an exercise capacity testing (2011). The normal range for a healthy person is 95% to 99% in normal air conditions. The sensation of breathlessness can cause discomfort and most important of all fear and anxiety. Ramage et al. (2016) reported one of the reasons for people not attending pulmonary rehabilitation was due to fear and anxiety. One of the interviewed participants mentioned *"That's the thing that's really worrying me. I don't want to go there and do all these things,*

and then the next couple of days be like, I can't breathe or I'm too worn out to do anything you know"(Participant 59).

The promising improvement made in the CRQ dyspnoea domain was consistent with previous research. Hernandez et al. (2000) found in their 60-patient RCT for people living with COPD that a simple home-based programme was able to achieve improvement in post-effort and basal dyspnoea. Ghanem et al. (2010) found that at the end of their two-month long home-based pulmonary rehabilitation study participants were able to achieve statistically and clinically significant improvement in the CRQ dyspnoea domain when compared to the control (usual medical therapy) group (2010). A study, in Germany, which examined a home-based exercise training for people living with moderate COPD also found a positive effect on the participants' breathing status. du Moulin et al. (2008) reported a clinically and statistically significant improvement in the participants' CRQ dyspnoea domain with the home exercise option in their 20-participant RCT.

The current study also identified that the performance of the home-based pulmonary rehabilitation in supporting the emotional aspect of people living with COPD was not significantly different from the centre-based pulmonary rehabilitation option. As stated previously in the literature review, it is well known that people living with a chronic medical illness would have higher depressive and anxiety levels (Lou et al., 2012; Nowak et al., 2014). The current study had shown participants involved in the home-based pulmonary rehabilitation had a mean baseline value of 30.1 in the CRQ emotional function domain and improved to 34.3 at the end of the eight-week rehabilitation.

The CRQ emotional function domain improvement in the home-based pulmonary rehabilitation was supported by research. In the study by Ghanem et al. (2010) the emotional function domain of the home-based participants improved from a baseline of 22.1 to 33.5 at

the end of the programme. The change margin was both statistically and clinically significant ($p < 0.05$). Hernandez et al. (2000) showed in their randomised home-based training programme trial, that the emotional aspect of the quality of life in people living with COPD could be improved by using a home-based programme. Their participants had a baseline mean value of 30.8 and, when reassessed 12 weeks later, the participants were able to achieve a mean value of 36.5, with a $p < 0.05$, both clinically and statically significant improvement (Hernandez et al., 2000); however du Moulin et al. (2009) suggested differently. They have found in their study, despite the improvements made in other CRQ domains in their participants, the CRQ emotional function domain did not achieve any significant improvement at the 3-month and 6-month measurement post intervention.

The phenomenon can be explained by the Alexopoulos et al. (2006) study. The authors enrolled 69 participants with the diagnoses of major depressive disorder (also known as MDD) and COPD in an inpatient pulmonary rehabilitation. At the end of the study, the authors had found these older depressed participants were responsive to the pulmonary rehabilitation, showing improvement of the depressive symptoms and disability (Alexopoulos et al., 2006). The authors concluded that the pulmonary rehabilitation programmes not only offered the participants the known clinical benefits but also behaviour intervention and supports which led to higher satisfaction with treatment regime (Alexopoulos et al., 2006). All these components together were thought to be the predictors of favourable outcomes for major depressive disorder (Alexopoulos et al., 2006). In the home-based pulmonary rehabilitation, the participants were seen at home. Once assessed and an exercise programme was designed for the participant, there was no other mechanism set in place to increase participants' social interaction other than the weekly telephone call to check on progress. In a centre-based pulmonary rehabilitation, the participants would need to make twice weekly outings to the programme venue, meet up with clinicians and interact with other participants

in the class. This is the type of support and interaction a participant undertaking the home-based pulmonary rehabilitation would miss out on.

The current study also suggested no statistically significant difference between the centre-based pulmonary rehabilitation and home-based pulmonary rehabilitation groups in the CRQ mastery domain, which measured the level of control the participants felt to their breathing condition. Both groups had similar baseline values, centre-based pulmonary rehabilitation: 19.1 and home-based pulmonary rehabilitation: 18.7, and clinically improved by over 3 units in both the centre-based pulmonary rehabilitation group to 22.2 and the home-based pulmonary rehabilitation group to 22.0.

Hernandez et al. (2000) supported the performance of home-based pulmonary rehabilitation in improving participants' mastery level. The participants in Hernandez et al.'s home-based training group were able to improve their mastery level by 2.5 units, from 19.4 to 21.9 after 12 weeks of training; however, Moore et al. (2009) and du Moulin et al. (2009) were not able to demonstrate any significant improvement in the mastery domain in their studies. The small randomised control home-based study by Moore et al. (2009), on home exercise video programme for people living with COPD, showed an improvement of only 0.7 unit in the home based group which was neither statistically nor clinically significant. du Moulin et al. (2009) reported an even smaller improvement in the CRQ mastery domain of 0.3 units 3 months after a home-based intervention was instigated. This less encouraging evidence in the mastery domain may be attributed to the lack of feedback by the participants and also a lack of co-designing a self-management plan with the participants. To gain more control of a chronic illness and in attempt to break the chronic element of the cycle, requires the participant to learn a new set of skills that they are comfortable in using and constantly reshaping, readjusting it to fit into their daily routine. In some of the home-based exercise or rehabilitation groups the literature, participants would have very limited feedback once the

initial contacts and an exercise programme were developed for them. This may explain why in some research the limited improvement is seen in the CRQ mastery domain.

The current study identified no statistically significant difference in the CRQ fatigue domain between the home-based pulmonary rehabilitation and centre-based pulmonary rehabilitation groups. The fatigue domain describes how one's activity or energy level was affected due to the breathing condition; however, the study revealed that the centre-based pulmonary rehabilitation was able to achieve a higher and clinically significant improvement at the end of the programme in contrast to the home-based pulmonary rehabilitation. The home-based pulmonary rehabilitation was only able to achieve a mean change of 1.7 point compared to the 3.1 points achieved by the centre-based pulmonary rehabilitation participants. In other words, both the home-based pulmonary rehabilitation and centre-based pulmonary rehabilitation were able to achieve significant improvement in the fatigue domain, but the centre-based pulmonary rehabilitation was able to make a more obvious improvement.

Hernandez et al. (2000) reported a significant improvement in CRQ fatigue domain for their home-based training programme for people living with COPD. A change of close to 4 points, from 17.4 to 21.1 for the home-based group with $p < 0.05$. du Moulin et al. (2009) also reported significant improvement in their participants going through a home-based exercise programme when compared to the centre based group with $p < 0.05$. Moore et al. (2009) also reported significant improvement in the CRQ fatigue level in their home video exercise study. The clinically significant gain in the centre-based pulmonary rehabilitation group, in my study, can be attributed to challenges faced to ascertain or to verify that the home-based pulmonary rehabilitation participants had been doing the exercises effectively. Compared to the centre-based pulmonary rehabilitation, the home-based pulmonary rehabilitation participants had to take up more ownership in adapting the exercise regime to their normal daily life without much direct supervision from the clinician. The effect of the exercise

carried out by the home-based pulmonary rehabilitation would be difficult to measure. Moore et al. (2009) also discussed the lack of direct supervision and noted that this may lead to a reduction in the effect of the exercise. The variable interpretation of the Borg scale (intensity), weight selection for resistance type of exercises, exercise frequency, and the lack of formal progression to the intensity of the exercises were all commented on as the possible factors that could have been more closely monitored (Moore et al., 2009). It is also possible that people making the effort to attend a centre-based pulmonary rehabilitation are, in general, more motivated, or have a greater ability to create change. The effort used in getting to the different sessions at the centre-based pulmonary rehabilitation could also mean an increase in the activity level for the participant.

Overall, the primary outcome measure, CRQ, provided useful input into the performance evaluation of the home-based pulmonary rehabilitation. The home-based pulmonary rehabilitation performed equally impressively in all domains of the CRQ when compared to the centre-based pulmonary rehabilitation. The only advantage the centre-based pulmonary rehabilitation had was achieving clinically significant improvement in the CRQ fatigue domain.

Secondary Outcomes

Four secondary outcome measures were used in this thesis project. They were the Hospital Anxiety and Depression Scale (HADS), the COPD Assessment Tool score (CATS), one-minute sit-to-stand test (1MSTST) and the EuroQol five dimension questionnaire (EQ-5D).

The HADS and CATS measurements revealed no significant difference between the home-based pulmonary rehabilitation and centre-based pulmonary rehabilitation groups. In other words, home-based pulmonary rehabilitation was performing as effectively as the centre-based pulmonary rehabilitation in supporting people living with COPD and mental health

issues, on the basis of the HADS results. The CATS measurements indicated the home-based pulmonary rehabilitation participants were able to learn new knowledge equally as well as the centre-based pulmonary rehabilitation group and also able to implement changes and improvements into their normal activities of daily living, leading to better self-management skills.

Unfortunately the same could not be said for the 1MSTST and EQ-5D between the two groups. In the current study, despite both home-based pulmonary rehabilitation and centre-based pulmonary rehabilitation groups having changes in the participant's exercise capacity, the improvement in the centre-based pulmonary rehabilitation was much more obvious. In the home-based pulmonary rehabilitation group, there was no change (-0.2 repetition) in the 1MSTST value before and after attending the programme as compared to a mean change of 2.5 in the centre-based pulmonary rehabilitation group before and after the programme, which is a difference of 2.8 repetitions between the two groups. The plausible reason to explain this observation could be due to the small sample size of the home-based pulmonary rehabilitation group (20), the lack of exercise supervision in the home-based pulmonary rehabilitation (as previously mentioned in the CRQ fatigue section) and the potential selection bias of the home-based pulmonary rehabilitation participants. It is important to note that the concept of home-based pulmonary rehabilitation was first thought of due to a significant number of referred participants not able to attend or complete a pulmonary rehabilitation programme due to various reasons. As was outlined in the demographic profile section of this chapter although the home-based pulmonary rehabilitation participants were younger a larger proportion of them were in the severe category of COPD. This group of participants were in general less committed, did not seem to understand the benefits of rehabilitation, and (probably due to the severity of their COPD) they are living with more breathlessness. On top of the above selection bias reasons, another important factor would be

the lack of direct supervision to support, encourage, and progress participant's exercise status. All these factors, would lead to a less favourable results in the exercise tolerance related outcome measures (i.e. CRQ fatigue domain and 1MSTST).

In the EQ-5D outcome measure, the home-based pulmonary rehabilitation group appeared to be no worse than the centre-based pulmonary rehabilitation group in helping the participants to move towards a more positive experience in their quality of life. However, looking purely at the numbers, the centre-based pulmonary rehabilitation appeared to be able to provide bigger and more significant changes to the lives of the participants. Due to the lack of complete data sets in the control centre-based pulmonary rehabilitation group from the historical database, this study had referred to a reference range tested and provided by Pickard et al. (2008) and the minimal clinical important difference suggested by Zanini et al. (2015) to analyse the data in hand. It is interesting to see, that on the basis of the EQ-5D indices, the home-based pulmonary rehabilitation had a lower perception of quality of life at the beginning of the programme (0.59) when compared to the centre-based pulmonary rehabilitation group (0.62) and reference range (0.60-0.78) provided by Pickard et al. (2008). Once again, this result is not unexpected because of the selection bias mentioned previously that more home-based pulmonary rehabilitation participants were living with more severe COPD. The pulmonary rehabilitation programmes were able to improve the values and elevated both groups' EQ-5D indices to within the expected reference range, but still below the mean reference value (0.69).

In the EQ-5D VAS domain, despite the lower quality of life perception in the home-based pulmonary rehabilitation group, mentioned previously, the home-based pulmonary rehabilitation participants tended to feel they were at a better health state when compared to the centre-based pulmonary rehabilitation participants (6.67 vs. 5.85). At the end of the programmes, both groups were able to make positive improvement to the visual analogue

scale; however, both groups were not able to reach the recommended minimal clinical important difference of 0.8. The home-based pulmonary rehabilitation made a 0.66 point change and the centre-based pulmonary rehabilitation, 0.35 change. A possible explanation to this interesting EQ-5D VAS finding could be due to the subjective self-rating nature of the questionnaire. The answers to the questionnaire would be based on the perceptions the patient had on the day. These perceptions can be influenced by many external factors such as activity level, mood, life experiences, and socialisation. Most of the participants in the home-based pulmonary rehabilitation group were mostly house bound or felt more comfortable staying at home. The lack of socialisation may lead to a distorted perception of what is good health. Those living with COPD and who had remained active in their community quite often reported to the pulmonary rehabilitation service team that that they felt embarrassed coughing or becoming breathless with minimum exertion in front of their family and friends. These active people living with COPD would get regular feedback and comments from people without breathing conditions saying their breathing is “a bit off” or asking them “do you need help”. These comments actually made these active people very conscious of their breathing condition constantly. In contrast the more house-bound home-based pulmonary rehabilitation participants may develop a false sense of *good health* because of a lack of (or reduced exercise challenges) at home and a lack of feedback from people without a breathing condition. Another common phenomenon when visiting these home-based pulmonary rehabilitation participants is they would avoid making themselves become breathless. A common sight would be upon arrival of the home visit, the individual would be sitting in a comfortable Lazyboy couch with the leg rest up, watching television. When interviewed on their breathlessness status during the day, quite often these participants would respond saying their breathings were “fine” or “good”. But with further questioning the participants would share how difficult it was to walk from the living room to the bedroom and how making a cup

of tea standing up in the kitchen would make them breathless. Their solution to the problems these activities of daily living created was to rely on the support provided by the spouse, family members, or social services. In other words, during the day, the individual would be supported and helped by external sources so the chance of having to exert him or herself would be minimal. These participants' reports of breathing as being "fine" or "good" was not a false statement but merely the result of a strategy that had been developed over the years to reduce the unpleasant experience of breathlessness. Just like any fitness training regime, however, those living with breathing conditions should challenge their breathlessness status every day with exercises to improve their overall quality of life.

Spirometry

It is worth noting in the study, the home-based pulmonary rehabilitation group had 5% of the participants without a spirometry result. The larger than expected percentage could be due to the small sample size ($n=21$) of the group but this value could also be uncovering another serious issue, regarding access to a standardised spirometry test for people in the community. Chronic obstructive pulmonary disease is demonstrated by a non-reversible airflow obstruction in spirometry, hence the access to spirometry testing is essential to a diagnosis of COPD (GOLD, 2013). Prior to 2007, standardised spirometry was carried out only at one central venue, the Christchurch Hospital Respiratory Physiology Laboratory. It is paramount to have a certified and standardised spirometry testing process in place because misdiagnosis of COPD can be as much as 27% (Jones et al., 2008). At the central venue, there were close to 8,000 referrals a year and only about 850 of these referrals were from the primary health care setting (Epton et al., 2015). As suggested in the introductory chapter, the estimated COPD population in the Canterbury region should be between just over 16,000 to close to 77,000 people. In other words, 8,000 referrals a year is only the tip of the ice berg. It is unrealistic to expect the hospital service to continue to perform all the spirometry testing

because most people in the Canterbury region do not live centrally and the demand for spirometry will only continue to rise (Epton et al., 2015). In 2008, a team of clinicians and scientists developed a quality assurance and education framework and a virtual interface software so that more people, especially from general practices, can be trained to deliver standardised spirometry. This had led to an extra 5,409 high quality spirometry tests being delivered in the community between the years 2009 and 2013 (Epton et al., 2015). It is hoped that with this free service now readily available at 10 geographically chosen approved providers more people living with a breathing condition would have easier access to find out what their lung function is like. It is also worth keeping in mind that, regardless of the ease of access to a service, if someone in the community does not have the finance and means to access a form of transportation, does not feel comfortable or supported to attend to such a service, or does not feel there would be any health benefits in having a spirometry test, then they will still not have it done. It is, therefore, important for the service as a whole, if at all possible, to put in place the non-medical support first so that individuals would have a greater chance of participating in the required medical intervention.

Home-based pulmonary rehabilitation and centre-based pulmonary rehabilitation processes

The length of the home-based pulmonary rehabilitation, eight weeks, was set in reference to the centre-based pulmonary rehabilitation programmes. As mentioned in the introductory chapter, Spruit et al. (2013), in their analysis were unable to identify and justify what would be the optimal number of sessions per week and staff-to-patient ratio for each of the centre-based pulmonary rehabilitation sessions. Participants in the centre-based pulmonary rehabilitation, on some occasions, were unable to commit to the whole of the programme, designed to deliver two sessions a week, and every session for two hours. Programmes that are designed to support behavioural and physical changes should happen as often as possible and for as long as possible; however this approach is not practical nor realistic. The most

common explanation as to the inability to attend the programme related to the structure or format of the programme, the number of days required per week, the time the programmes were run, or the amount of time spent per session (Ramage et al., 2016). The recommended number of exercising sessions per week required for health purposes ranges from three to five sessions and each session should last for 20-30 minutes. For centre-based pulmonary rehabilitation, it was thought two sessions a week would be sufficient because the service would expect the participant to carry out at least one exercise session on their own at home when they are attending a pulmonary rehabilitation programme. This would make up the number of sessions to the minimum requirement of three exercise sessions per week. For the home-based pulmonary rehabilitation, the approach was different. Home based pulmonary rehabilitation provided once a week telephone call support in hope that the participants would follow through the exercise regime developed at the initial assessment session. This, as mentioned previously in this chapter, is one of the limitations of the home-based pulmonary rehabilitation programme, the inability to verify if the exercises actually happened. Changes, however, in technology may be able to solve this problem, such as the use of activity tracking device like a FitBit will be able to provide this data.

The conceptualisation of the home-based pulmonary rehabilitation was based on the significant number of pulmonary rehabilitation referrals that were not able to translate into the completion of a pulmonary rehabilitation programme. The venues chosen for the centre-based pulmonary rehabilitation were based on Christchurch Hospital Respiratory Service data on COPD related discharges. The University of Canterbury Geography Department was then able to report on the hot spot areas of residence for patients with COPD related discharges. This was very useful information to have when looking for the right pulmonary rehabilitation venues in the community. No venue will ever be perfect for everyone, but by using the data to determine optimal sites venues will be more accessible and more convenient to the

potential participants' homes. Furthermore, the reasons for non-attendance of the centre-based pulmonary rehabilitation are so wide and complex, it is not an issue that can simply be solved by placing a pulmonary rehabilitation venue right next to patients' homes so they will attend the programme. The pulmonary rehabilitation service recognised that when dealing with a group of people, who live with a chronic condition, things would always be more complex than it first appeared. First, they need to manage the fluctuation of symptoms caused by the chronic condition on a daily basis, whether it is a physical or emotional challenge. In addition, this group of people also need to deal with family, work, finance, and all other aspects of a normal life. All these can greatly influence the motivation for a patient to attend a centre-based pulmonary rehabilitation. This was the exact reason that home-based pulmonary rehabilitation would be an ideal solution, offering the people of Canterbury a different model for pulmonary rehabilitation. In cases where the centre-based pulmonary rehabilitation did not work for the individual the pulmonary rehabilitation service now has another equally effective option, the home-based pulmonary rehabilitation.

Lastly, it may seem as if not much effort was put in place to follow up on the two home-based pulmonary rehabilitation participants who were not able to have post-programme assessments. The pulmonary rehabilitation service believes strongly in the informed consent process and also the service is looking after a population group that had a vast amount of experience in life and caring for themselves. Ideally, any post-programme data should be collected within two weeks after the completion of the programme. This is to prevent any deconditioning (if the participant chooses to stop exercising after the programme) or skewing (if the participant continues to exercise and therefore improves his fitness level) of the data. When making the post-assessment appointments, the participants were informed of the reasons and content of the home visit and they have the right to agree or disagree with the appointment. If they disagreed, an explanation would be given on the benefits of having a

post assessment and alternate appointment times would also be offered. Even so, two home-based pulmonary rehabilitation participants decided not to have post-assessment conducted.

Study limitations

Recruitment limitations: One important limitation of this study would be the pool of research participants. The pulmonary rehabilitation governance group agreed to test the concept of the home-based pulmonary rehabilitation on the group of participants who were not able to complete a centre-based pulmonary rehabilitation or whom the service had failed to establish formal contacts with through the standard centre-based pulmonary rehabilitation processes. In other words, the research participants were likely to be coming from a less motivated, less engaged with health services position, and may be living with more severe symptoms of respiratory conditions. These second chance participants may not represent the true general pulmonary rehabilitation participants in the Canterbury region. But, this group of people may also be the most suitable group to test this new home-based pulmonary rehabilitation service on, the very people the service is trying to reach out to. There are a couple of reasons for this. They already knew about the pulmonary rehabilitation service, and had some understanding of the process and the purposes of pulmonary rehabilitation. Second, the majority of participants, who failed to fully engage in the pulmonary rehabilitation services, had genuine health or commitment reasons. By removing the commitment and transportation barriers, these participants in need may once again establish contacts with the health services and improve their health by participating in the home-based pulmonary rehabilitation.

The small home-based pulmonary rehabilitation sample size (n= 21) may exaggerate the effects of the home-based programme. This limitation was mainly due to the limited resource available, the physician time for patient assessment, and only one physiotherapist (myself) was available to monitor and follow up on all participants.

Time frame limitations: The assessment time frames were fixed and rigid in this research study to ensure results data could be produced within a tight time frame. This meant some potential participants were left out of the study. These potential participants were excluded from the programme when they were unable to complete the initial home visit assessment either due to not being at home at the agreed time or because they called to cancel the home visit appointment without rebooking. Similarly at the end programme assessment, every effort was made to re-assess the home-based pulmonary rehabilitation participants within a two-week period. If the participants were unavailable to be reassessed in the two-week window due to another commitment, sickness or death, they were excluded from the study. The rigid assessment structure is to be regretted, but with very limited staff and time resources, this was the only possible approach to keep the home-based pulmonary rehabilitation project moving forward.

Data limitation: The incomplete data sets from the historical spreadsheet hindered a more complete quality of life (EQ-5D) comparison analyses between the home-based pulmonary rehabilitation and centre-based pulmonary rehabilitation. The data storage issue was only identified in recent years. In 2013, the pulmonary rehabilitation service decided to migrate as much data as possible to the new MedTech system, but then they realised it would be too resource intensive to migrate all the data from 2009 to 2013 to the new database. The service, therefore, decided to set a specific time to stop using the old storage format and to begin storing data into the new system. The old storage format was saved in Excel spreadsheets and it was very difficult to access because the data were stored under multiple file names and in poorly organised folders. This problem only became obvious when I began interrogating the routinely collected data for research purposes much was lost or not recorded in a useful format for extraction.

The Hawthorne effect: This is the effect of knowing you are being studied. Mayo (1933) described this effect as the behavioural changes made by the participants as a result of knowing that they were being studied or monitored. This may motivate the participants to make some positive changes, unrelated to the study, to their lifestyles because they wanted to be helpful to the study. From the consent form, the 21 home-based pulmonary rehabilitation participants understood they were part of a pilot study, the result would be reported to the governance group and potentially changing the health practice. This alone, may positively change the attitudes of the participants and produce favourable results.

Summary of key findings

The key findings of this study are outlined according to the order in which they were discussed in this chapter. Each of the key findings will be described in a concise and abbreviated manner. More information on each of the key findings can be found within this chapter as required.

- The home-based pulmonary rehabilitation was able to show a better gender distribution (almost at half of each gender) when compared to the centre-based pulmonary rehabilitation (one third males vs. two third females). This finding can be explained by the men's avoidance in health utilisation. But the avoidance barrier appeared to have been removed when the health service was delivered in the home.
- The home-based pulmonary rehabilitation model was able to capture people who are younger, with a mean age of 68.76 years compared to 74.61 years in the centre-based pulmonary rehabilitation. This finding may relate to the fact that people are working longer and reflect an older and healthier Canterbury population. People who could attend a centre-based pulmonary rehabilitation were most likely to be retirees which would explain the older mean age.

- The home-based pulmonary rehabilitation was able to have higher Māori representation when compared to the centre-based pulmonary rehabilitation. The home-based pulmonary rehabilitation had 14% of the participants who identified as Māori compared to 4% in the centre-based pulmonary rehabilitation. It is important to identify suitable approaches to care for the indigenous people of the land. The home-based pulmonary rehabilitation model seemed to be a more acceptable mode of delivery to the Māori community.
- The data seemed to suggest that in the home-based pulmonary rehabilitation there was a higher proportion of the members (50%) who had severely obstructed airway disease compared to 40% in the centre-based pulmonary rehabilitation group. People living with more severe airway disease may prefer to be assessed and seen at home. This group of people may be more symptomatic from their breathing conditions and as a result more reluctant to leave the house.
- The home-based pulmonary rehabilitation was able to improve the participants' perception of their breathlessness as much as the participants in the centre-based pulmonary rehabilitation.
- The home-based pulmonary rehabilitation performed as well as the centre-based pulmonary rehabilitation in managing participant's emotional functions.
- There is no statistically significant difference between the home-based pulmonary rehabilitation and centre-based pulmonary rehabilitation in how the participants felt they are in control of their breathlessness.
- There is no significant difference between the home-based pulmonary rehabilitation and centre-based pulmonary rehabilitation in supporting participants to improve their fatigue status; however, the centre-based pulmonary rehabilitation group was able to achieve a significantly higher improvement when compared to the home-based

pulmonary rehabilitation group. This finding can be explained by the lack of supervised exercise sessions in the home-based pulmonary rehabilitation group and possibly the increase in the activity level by merely making an effort to attend a centre-based pulmonary rehabilitation.

- The HADS questionnaire revealed that the home-based pulmonary rehabilitation and centre-based pulmonary rehabilitation produced similar outcomes in the management of anxiety and depression.
- The CATS questionnaire suggested that both home-based pulmonary rehabilitation and centre-based pulmonary rehabilitation were able to provide the participants similar skills in managing their own breathing conditions.
- In the 1MSTST measure, both home-based pulmonary rehabilitation and centre-based pulmonary rehabilitation showed the ability to improve participant's ability to perform the test; however, the centre-based pulmonary rehabilitation was able to produce a greater improvement when compared to the home-based pulmonary rehabilitation group.
- In the EQ-5D questionnaire, both the home-based pulmonary rehabilitation and centre-based pulmonary rehabilitation groups were able to improve participant's quality of life. But once again, the centre-based pulmonary rehabilitation was able to produce a stronger result at the end of the programme.
- A larger than expected proportion of the participants in the home-based pulmonary rehabilitation did not have a spirometry result. This could be due to the lack of access to spirometry testing or a lack of non-medical support to the participants, such as transport, to access spirometry.

A number of key health implications and recommendations to the service were generated from the key findings. The recommendations are listed according to the order which they were discussed in this chapter. These points are also written in an abbreviated manner. More information on each point can be found in the discussion chapter or in the literature review of this thesis. The intent of the following recommendations is to assist and encourage clinicians working in the centre-based pulmonary rehabilitation setting to consider home-based pulmonary rehabilitation as a clinically acceptable intervention to people who were not able to complete a centre-based pulmonary rehabilitation.

- Home-based pulmonary rehabilitation should be considered to be clinically as effective as the centre-based pulmonary rehabilitation when dealing with people or communities with increased needs. The thesis project has shown the positive effects of the home-based pulmonary rehabilitation which were as effective as the centre-based pulmonary rehabilitation.
- The centre-based pulmonary rehabilitation providers should analyse the demographic and outcome measures data on a regular basis so that the pulmonary rehabilitation service can continue to evolve according to the needs of the users. For example, home-based pulmonary rehabilitation would be an ideal rehabilitation option if the service would could offer this intervention to Māori males, who are in their 60s and who have severe airway obstruction disease.
- The patient's own home would be the best place for learning new knowledge and a comfortable environment to start modifying their lifestyle for the better. At the home setting, the clinician and patient power imbalance is minimised. The home-based pulmonary rehabilitation provides exactly this service to people living with chronic respiratory condition in the community.

- In situations where people living with chronic respiratory illness could not attend centre-based pulmonary rehabilitation, but would benefit from rehabilitation, they should be offered alternative options. The alternative options could vary from a one-off home visit with a physiotherapist or a nurse to go over self-management strategies to modified forms of pulmonary rehabilitation for example the home-based pulmonary rehabilitation or after-hours information sessions.
- When delivering a home-based pulmonary rehabilitation, more effort and time should be spent on the supervision and progression of the home-based exercises. The weekly follow-up with the patient should include specific instructions on making sure the set exercise intensity at the first home visit is still effective and continue to motivate the participants to challenge his or her comfort zone. This is aimed to maximise the effect of fatigue management and fitness training through exercise.

At time of writing

- In December 2016, the Pulmonary Rehabilitation Working Group, the governance group to the Canterbury Pulmonary Rehabilitation Service, completed its review of the report generated from this thesis project and gave its mandate to start home-based pulmonary rehabilitation service in the Canterbury region, beyond a pilot study.
- To the best of our understanding, this would be the first structured home-based pulmonary rehabilitation service in New Zealand.
- A one page flowchart was produced to assist clinicians to better understand the home-based pulmonary rehabilitation (Appendix N).
- A one page long patient information flyer was generated. This flyer will go out together with the appointment letter in the post once the service has established contact with the home-based pulmonary rehabilitation participant.

- A new strategy, using pedometers was put in place, as a result of the review, to better monitor the exercise progress of the home-based pulmonary rehabilitation. This was put in place with the hope that with more visual and motivating feedback there would be an improvement in the final level of fitness.
- An extra education component was added to the weekly contact. Each week, there will be a specific discussion topic to go through with each participant. This was put in place to encourage the home-based pulmonary rehabilitation participants to engage with the valuable information resources given to them on the initial visit. With a better understanding of their own condition there can be better self-management skills.
- The first home-based pulmonary rehabilitation patient Mrs A was seen on the 4th April 2017 under the new and PRWG mandated framework. Currently, there are 23 active referrals on the home-based pulmonary rehabilitation list.
- The Canterbury Pulmonary Rehabilitation Service has successfully recruited an exercise trainer (at 0.6 full-time equivalent) to work together with the physiotherapist in charge of the home-based programme, to ensure adequate support to the patients and smooth running of the programme.
- In addition to the above, it has come to my attention of a just-published article with very similar process to this thesis project. Holland et al. (2017) also noticed the poor uptake in the centre based pulmonary rehabilitation programmes in Australia. Therefore, the authors decided to undertake a randomised controlled trial with 12-month follow up to examine the effect of the home based pulmonary rehabilitation programme in comparison to the centre based pulmonary rehabilitation over a two and half year period (October 2011 to April 2014). The authors recruited 166 participants from two tertiary based hospitals in Melbourne. The participants were then randomly assigned to either the home based or the centre based programme. Eighty-six

participants were allocated to the centre based rehabilitation programme and 80 were enrolled to the home based rehabilitation programme. The centre based programme, was the standard eight-week long programme, whereas the home based programme, the participants would receive a home visit follow by seven weekly phone contacts from a physiotherapist. Holland et al. (2017) had found that in their primary outcome measure, the analysis has confirmed non-inferiority of the home based programme in the six-minute walking test and in the secondary outcome measure, the chronic respiratory questionnaire, at the end-programme phase. Holland and colleagues (2017) also reported in their 12-month follow up, neither model was able to maintain effectively the improvement made at the end of the programmes. The authors concluded by recommending that home based pulmonary rehabilitation should be considered when centre based programme is not accessible by the participant. This recommendation concurs with the finding of this thesis project.

Recommendations for future research

- Future research should incorporate a follow-up period at 6-months and 12-months to examine the long-term effects of the home-based pulmonary rehabilitation. The immediate effects after completing a home-based pulmonary rehabilitation appeared to be no worse than the centre-based pulmonary rehabilitation. It would be useful to find out how long the carry-over effect lasts after completing a home-based pulmonary rehabilitation programme.
- The next home-based pulmonary rehabilitation study should recruit more participants to the intervention group. The current thesis study had 21 participants in the intervention group. A small sample size group means a small change in the group profile or outcome measure could easily exaggerate the final results.

- Further research could also look into the actual health cost benefit and the effect of the home-based pulmonary rehabilitation. Currently, the PRWG has been running an annual analysis on the number of respiratory related hospital admissions against those people who 1) were referred to the centre-based pulmonary rehabilitation; 2) attended less than eight centre-based pulmonary rehabilitation sessions (less than half of the programme); and 3) completed a centre-based pulmonary rehabilitation (attended more than eight pulmonary rehabilitation sessions). A similar analysis could also be done for the home-based pulmonary rehabilitation.
- A systemic review could also be conducted to find out what exercise equipment would be most beneficial to a home bound person living with a breathing condition. The current thesis study used an exercise DVD, but we have found the home-based pulmonary rehabilitation participants did not improve as much in the fatigue management and fitness level when compared to the centre-based pulmonary rehabilitation participants. The PRWG had added a pedometer to the exercise regime to motivate the participants to be more mobile.
- Finally, more research should look into what type of maintenance programme would suit these people who have completed home-based pulmonary rehabilitation. Currently, people who completed centre-based pulmonary rehabilitation are encouraged to go on to a maintenance exercise programme to maintain what they have gained. No such service exists for the less mobile, less motivated and home bound respiratory participants.

Concluding comment

This study has successfully demonstrated that the home-based pulmonary rehabilitation, a modified delivery model to the gold standard centre-based pulmonary rehabilitation practice, was still effective in supporting the participants to achieve positive changes. The home-based pulmonary rehabilitation was better at reaching out to the younger, male, Māori and the severe airway obstructed participant groups. The main weaknesses identified from the study results were the relatively small intervention sample size and the weaker improvement margins in the fatigue management and 1MSTST measures; however, these minor weaknesses should not discourage clinicians from rolling out home-based pulmonary rehabilitation in their communities. Simple strategies can and have been put in place to strengthen the improvement margins, for example a more structured weekly telephone contact with specific questions targeting and motivating the participants to exercise and learn from the given educational resources.

Lastly, as a New Zealand pioneer to the home-based pulmonary rehabilitation, based on the study results and literature review findings, there are three concluding comments to persuade clinicians and providers to consider implementing home-based pulmonary rehabilitation to their hard to reach participants living with chronic respiratory conditions.

1. The current thesis study has demonstrated that the home-based pulmonary rehabilitation performed no worse than the gold standard centre-based pulmonary rehabilitation in all outcome measures.
2. The current thesis study has also demonstrated that the home-based pulmonary rehabilitation was able to capture patient groups which were hard to reach out to in the traditional model, i.e. the males, Māori and severe airway obstruction patient groups.

3. The home-based pulmonary rehabilitation is a true patient-centred health delivery model where the participants were reviewed and treated at home.

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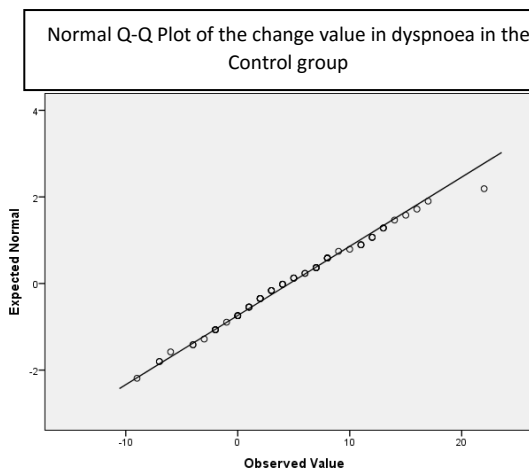
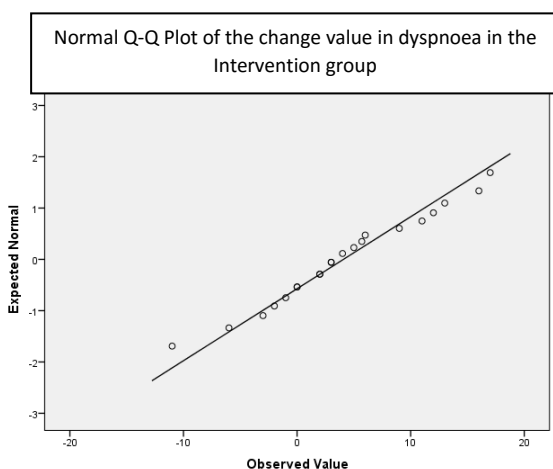
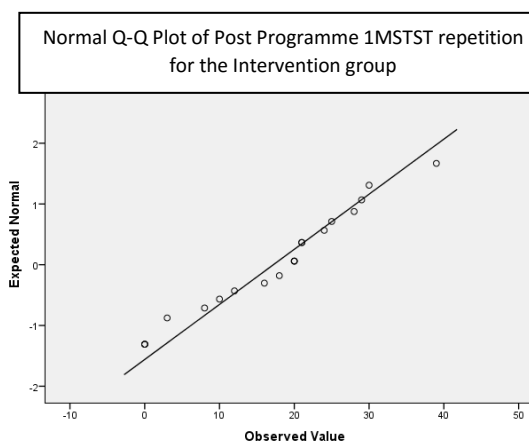
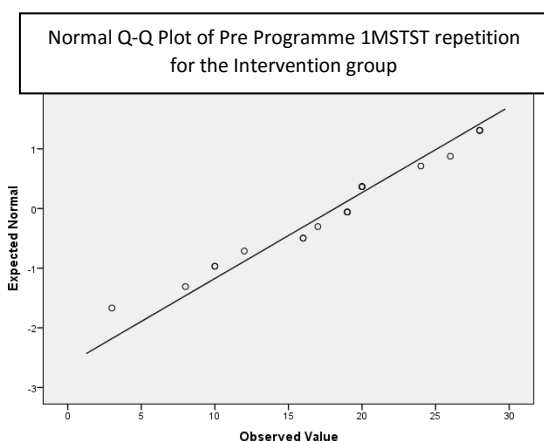
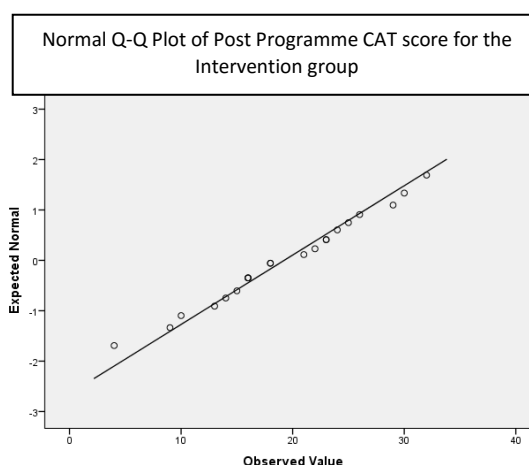
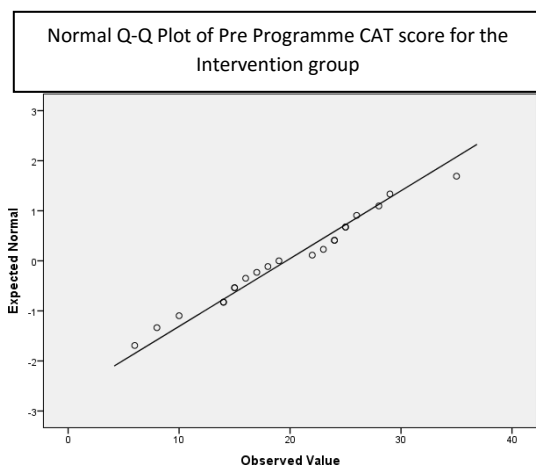
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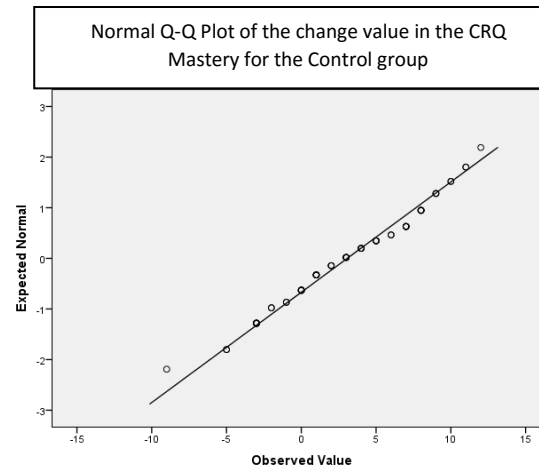
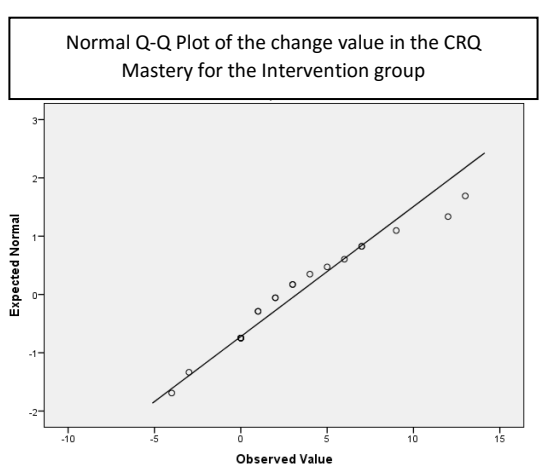
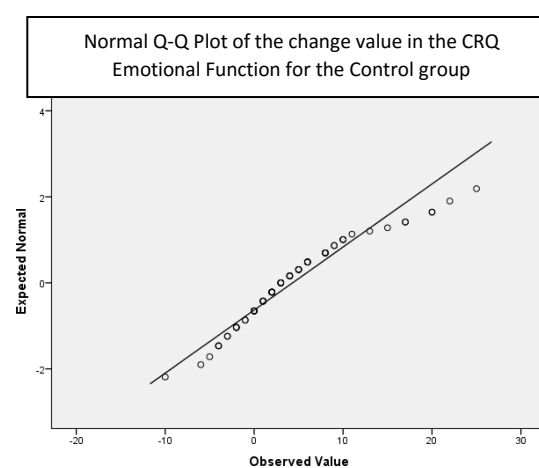
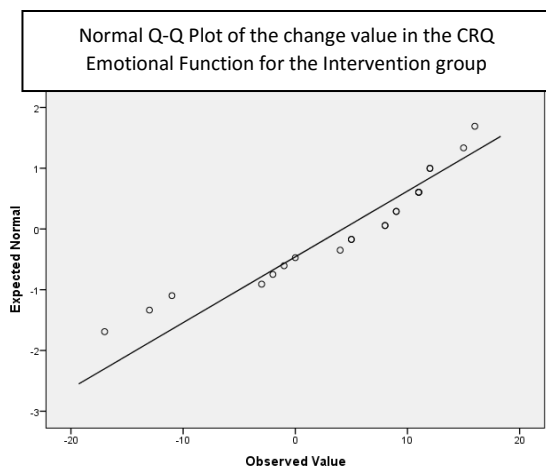
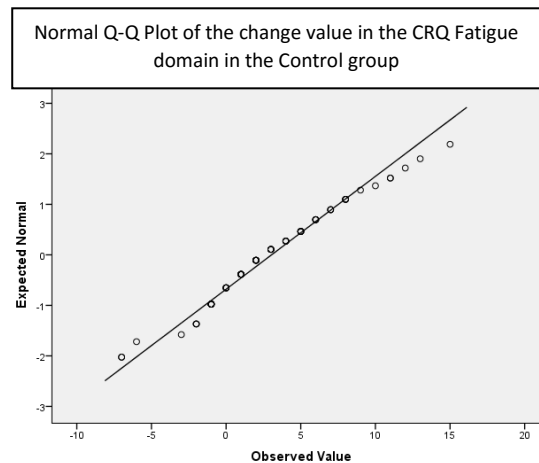
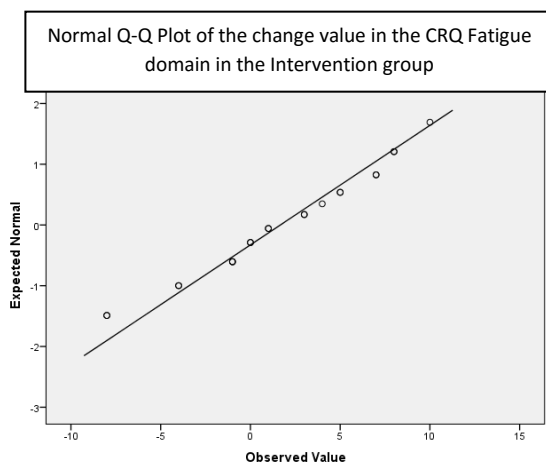
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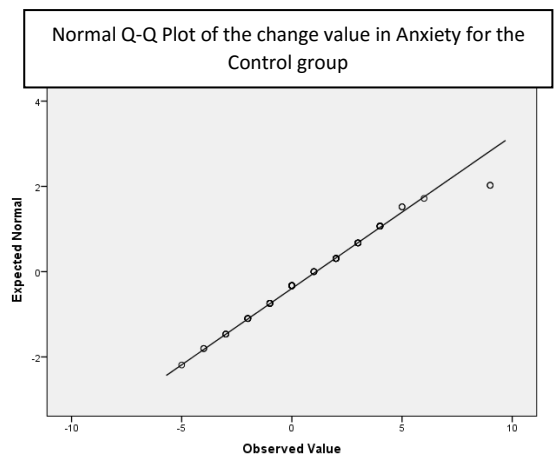
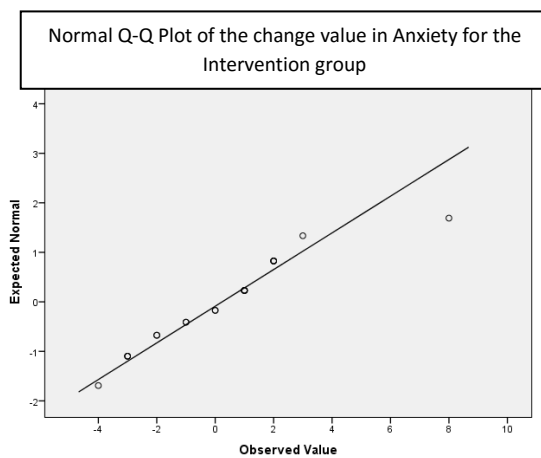
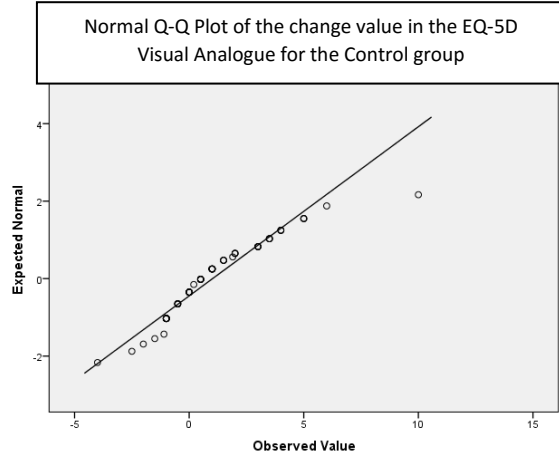
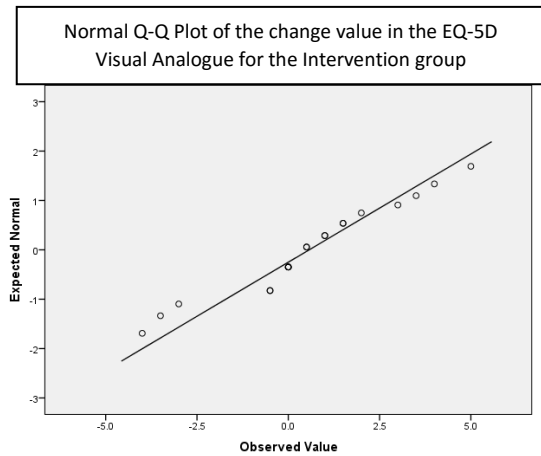
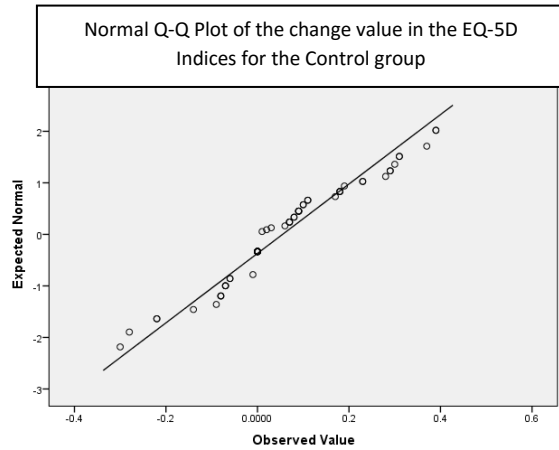
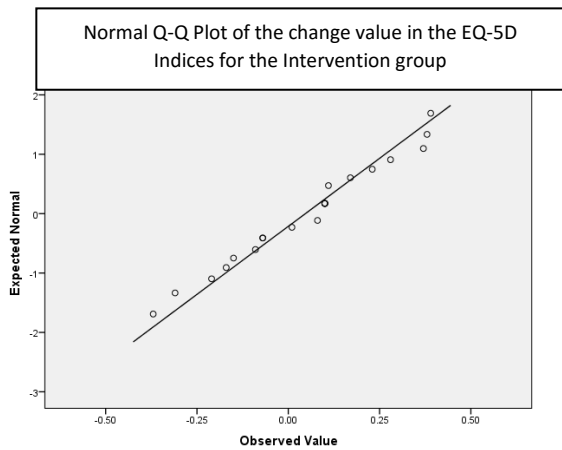
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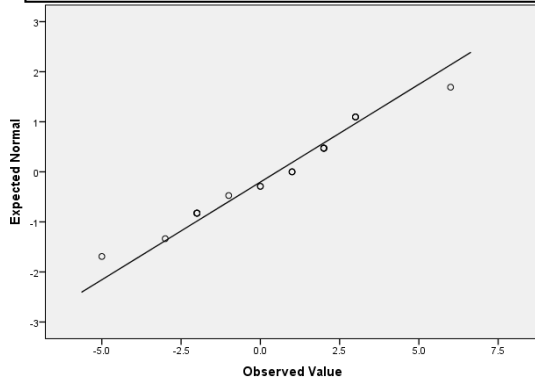
Appendix A: Actual Q-Q plot graphs for the outcome measures



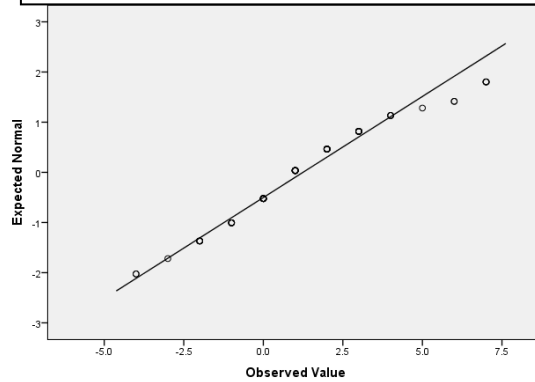




Normal Q-Q Plot of the change value in Depression for the Intervention group



Normal Q-Q Plot of the change value in Depression for the Control group



Appendix B: Human Ethics Committee approval letter



HUMAN ETHICS COMMITTEE

Secretary, Lynda Griffiths
Email: human-ethics@canterbury.ac.nz

Ref: HEC 2014/69

30 July 2014

David Chen
School of Health Sciences
UNIVERSITY OF CANTERBURY

Dear David

The Human Ethics Committee advises that your research proposal "To compare the effects of using a pedometer and DVD exercises on exercise tolerance in participants of the Canterbury home-based pulmonary rehabilitation programme" has been considered and approved.

Please note that this approval is subject to the incorporation of the amendments you have provided in your email of 29 July 2014.

Best wishes for your project.

Yours sincerely

A handwritten signature in black ink, appearing to read 'L. MacDonald'.

Lindsey MacDonald
Chair
University of Canterbury Human Ethics Committee

Appendix C: Information sheet

School of Health Sciences

University of Canterbury

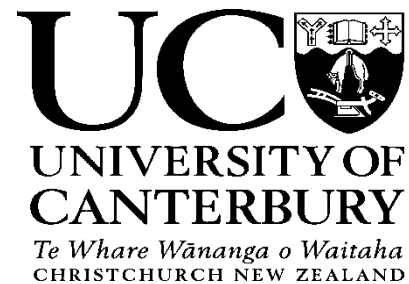
Private Bag 4800

Christchurch 8140

Tel: +64 3 366 7001

Fax: + 64 3 364 2490

Email: healthsciences@canterbury.ac.nz



Researcher; David Chen, daveynztw@gmail.com

Supervisor; Assoc. Professor Ray Kirk; School of Health Sciences, raykirk@canterbury.ac.nz

To examine the effects of DVD exercises on exercise tolerance in participants of the Canterbury home-based pulmonary rehabilitation programme

Dear,

My name is David Chen and I am a Masters student in the School of Health Sciences, Canterbury University. I am conducting a research study as part of the requirements of my master's degree and

I am investigating the effects of two basic exercise technologies (pedometer and DVD exercises) on exercise tolerance in the participants of the Canterbury home-based pulmonary rehabilitation in Canterbury.

The American Thoracic Society (ATS) and the European Respiratory Society (ERS) have jointly defined pulmonary rehabilitation as *"a comprehensive intervention based on a thorough patient assessment followed by patient-tailored therapies that include, but are not limited to, exercise training, education and behaviour change, designed to improve the physical and psychological condition of people with chronic respiratory disease and to promote the long-term adherence to health enhancing behaviours"* (ATS guidelines 2013).

The pulmonary rehabilitation is an evidence-based health intervention. It has been shown to reduce the risk of hospital admissions and mortality in people living with chronic obstructive pulmonary disease (Puhan, Scharplatz, Trooters & Steurer, 2005). The pulmonary rehabilitation programme is also known to demonstrate the effect of improving participants' dyspnoea, fatigue levels and the sense of control over their respiratory condition (Lacasse, Maltais & Goldstein, 2004). In the Canterbury HealthPathways website, the respiratory physicians described pulmonary rehabilitation to be "*at least as effective as inhaled medications*" (Canterbury HealthPathways, 2014).

The Canterbury pulmonary rehabilitation programme was established in the late 1980s in Christchurch. It was initially solely supported and facilitated by the Christchurch Hospital Respiratory Services in one central city venue. The advent of the Canterbury Initiative in 2009 and in accordance with the government's health direction "Better, Sooner, More Convenient health care in the community" the pulmonary rehabilitation programme was able to be expanded to the wider Canterbury community.

Over the last five years in the community, despite bringing the pulmonary rehabilitation venues closer to patients' neighbourhood, the uptake and drop-out rates were still consistent with the international data, far from ideal. Only around 1% of all the chronic obstructive pulmonary disease (COPD) patients accessed pulmonary rehabilitation and close to 50% (44%) drop-out rate after the participants were referred to the pulmonary rehabilitation by their health professionals.

Home-based pulmonary rehabilitation has surfaced in the recent years and thought to be the likely solution to the poor uptake and the high drop-out rates. It has been shown to be as effective as outpatient pulmonary rehabilitation and a reasonable alternative for managing people living with COPD (Mendes de Oliveira et al., 2010).

My research question is; 'Could the DVD exercise give forth a better exercise tolerance improvement in a home-based pulmonary rehabilitation' I intend to recruit 50 participants from the "Did-not-attend" folder of the Canterbury pulmonary rehabilitation Medtech database. I would offer the participants a one-off standardised education session based on the "Move on up" DVD. The participants will also be shown the exercises recorded in the "Move on up" DVD. I will follow the patients for eight weeks with weekly phone call or text messages. There will be objective and subjective assessments (CRQ, CAT score, 1-minute sit-to-stand, HADS and EQ-5D) pre and post intervention to monitor changes.

It is hoped that the findings of the study will give a clearer understanding of whether the DVD exercises can encourage improvement in exercise tolerance level and can the other assessment results from the Canterbury home-based pulmonary rehabilitation be comparable to the local and international data.

In this research, you will be treated by me, David Chen, a registered physiotherapist and referred to other health services as indicated. Follow up contacts via phone or text message will be done by me as well.

In the performance of the task there will be no risk to you in consenting to the intervention.

You may receive a copy of the project results by contacting me at the conclusion of the project.

Participation is voluntary and you have the right to withdraw at any stage without penalty. If you withdraw I will remove information relating to you prior to my thesis being submitted to the University of Canterbury.

The results of the thesis may be published, but you may be assured of the complete confidentiality of data gathered in this investigation: your identity will not be made public without your prior consent. To ensure anonymity and confidentiality no identifying names will be used in the thesis. The data will only be accessed by myself, the community respiratory team and my supervisor. A completed thesis is a public document and will be available through the UC library.

This project is being carried out as a requirement for my Masters in Health Sciences degree under the supervision of Ray Kirk who will be pleased to answer any concerns you may have about participation in the project.

This project has been reviewed and approved by the University of Canterbury Human Ethics Committee, and participants should address any complaints to The Chair, Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

If you agree to participate in the study, you are asked to complete the consent form.

Please txt or email me at;

daveynztw@gmail.com

DDI: 372 5100/ 021 242 5877

Kind regards

David Chen

Appendix D: Consent Form

School of Health Sciences

University of Canterbury

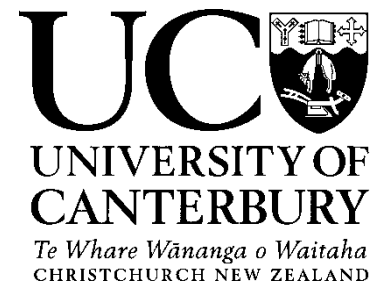
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Researcher; David Chen daveynztw@gmail.com

‘To examine the effects of DVD exercises on exercise tolerance in participants of the Canterbury home-based pulmonary rehabilitation programme’

I have been given a full explanation of this project and have had the opportunity to ask questions.

I understand what is required of me if I agree to take part in this research.

I understand that participation is voluntary and I may withdraw at any time without penalty.

Withdrawal of participation will also include the withdrawal of any information I have provided should this remain practically achievable.

I understand that any information or opinions I provide will be kept confidential to the researcher David Chen or his supervisor Ray Kirk and that published or reported results will not identify the participants or my place of work. I understand that a thesis is a public document and will be available through the UC library and the Community Respiratory Services team Office at 160 Bealey Avenue.

I understand that all data collected for the study will be kept in locked and secure facilities and /or in password protected electronic form and will be kept in the Canterbury Clinical Network Medtech system indefinitely.

I understand the risks involved in taking part in the study and how they will be managed if required.

I understand that I am able to receive a report on the findings of the study by contacting the researcher at the conclusion of the project.

I understand I can contact David Chen at daveynztw@gmail.com or Ray Kirk ray.kirk@canterbury.ac.nz for further information. If I have any complaints, I can contact the Chair of the University of Canterbury Human Ethics Committee, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz)

I would like a summary of the results with a tick box on the consent form ☐

By signing below I agree to participate in this research project.

I, _____ (please print your full name) consent to take part in the above study.

Signature _____

Date _____

Thank you for your time,

David Chen

CHRONIC RESPIRATORY QUESTIONNAIRE (Self Reported)

FOLLOW UP

NAME _____

DATE _____

Dyspnoea Questions 1 to 5
(Range of scores: 'Extremely short of
breath' = 1 to 'Not at all short of breath' = 7)
Fatigue – Questions 8, 11, 15, 17
Emotional function – Questions 6, 9, 12,
14, 16, 18, 20
Mastery – Questions 7, 10, 13, 19

University Hospitals of Leicester **NHS**
NHS Trust

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Appendix F: Questionnaires- HADS

Hospital Anxiety and Depression Scale (HADS)		GL assessment the measure of potential
Name: _____ Date: _____		
<p>Clinicians are aware that emotions play an important part in most illnesses. If your clinician knows about these feelings he or she will be able to help you more.</p> <p>This questionnaire is designed to help your clinician to know how you feel. Read each item below and underline the reply which comes closest to how you have been feeling in the past week. Ignore the numbers printed at the edge of the questionnaire.</p> <p>Don't take too long over your replies, your immediate reaction to each item will probably be more accurate than a long, thought-out response.</p>		
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>I feel tense or 'wound up'</p> <p>Most of the time A lot of the time From time to time, occasionally Not at all</p> <p>I still enjoy the things I used to enjoy</p> <p>Definitely as much Not quite so much Only a little Hardly at all</p> <p>I get a sort of frightened feeling as if something awful is about to happen</p> <p>Very definitely and quite badly Yes, but not too badly A little, but it doesn't worry me Not at all</p> <p>I can laugh and see the funny side of things</p> <p>As much as I always could Not quite so much now Definitely not so much now Not at all</p> <p>Worrying thoughts go through my mind</p> <p>A great deal of the time A lot of the time Not too often Very little</p> <p>I feel cheerful</p> <p>Never Not often Sometimes Most of the time</p> <p>I can sit at ease and feel relaxed</p> <p>Definitely Usually Not often Not at all</p> </div> <div style="width: 45%;"> <p>I feel as if I am slowed down</p> <p>Nearly all the time Very often Sometimes Not at all</p> <p>I get a sort of frightened feeling like 'butterflies' in the stomach</p> <p>Not at all Occasionally Quite often Very often</p> <p>I have lost interest in my appearance</p> <p>Definitely I don't take as much care as I should I may not take quite as much care I take just as much care as ever</p> <p>I feel restless as if I have to be on the move</p> <p>Very much indeed Quite a lot Not very much Not at all</p> <p>I look forward with enjoyment to things</p> <p>As much as I ever did Rather less than I used to Definitely less than I used to Hardly at all</p> <p>I get sudden feelings of panic</p> <p>Very often indeed Quite often Not very often Not at all</p> <p>I can enjoy a good book or radio or television programme</p> <p>Often Sometimes Not often Very seldom</p> </div> </div>		
<p style="text-align: center;">Now check that you have answered all the questions</p>		
<p>This form is printed in green. Any other colour is an unauthorized photocopy.</p> <p>HADS copyright © R.P. Snaith and A.S. Zigmond, 1983, 1992, 1994.</p> <p>Record form items originally published in <i>Acta Psychiatrica Scandinavica</i> 67, 361-70, copyright © Munksgaard International Publishers Ltd, Copenhagen, 1983.</p> <p>First published in 1994 by nferNelson Publishing Company Ltd.</p> <p>Published by GL Assessment Limited, The Chiswick Centre, 414 Chiswick High Road, London W4 5TF</p> <p>GL Assessment is part of the Granada Group</p> <p>Printed in Great Britain</p>		<p>TOTAL</p> <p>A D</p> <p>0 1 2 3</p>

Appendix G: Questionnaire- CATS

Your name :	Today's date:
-------------	---------------




How is your COPD? Take the COPD Assessment Test™ (CAT)

This questionnaire will help you and your healthcare professional measure the impact COPD (Chronic Obstructive Pulmonary Disease) is having on your wellbeing and daily life. Your answers, and test score, can be used by you and your healthcare professional to help improve the management of your COPD and get the greatest benefit from treatment.

For each item below, place a mark (X) in the box that best describes you currently. Be sure to only select one response for each question.

Example: I am very happy (0) X (1) (2) (3) (4) (5) I am very sad		
I never cough	(0) (1) (2) (3) (4) (5)	I cough all the time
I have no phlegm (mucus) in my chest at all	(0) (1) (2) (3) (4) (5)	My chest is completely full of phlegm (mucus)
My chest does not feel tight at all	(0) (1) (2) (3) (4) (5)	My chest feels very tight
When I walk up a hill or one flight of stairs I am not breathless	(0) (1) (2) (3) (4) (5)	When I walk up a hill or one flight of stairs I am very breathless
I am not limited doing any activities at home	(0) (1) (2) (3) (4) (5)	I am very limited doing activities at home
I am confident leaving my home despite my lung condition	(0) (1) (2) (3) (4) (5)	I am not at all confident leaving my home because of my lung condition
I sleep soundly	(0) (1) (2) (3) (4) (5)	I don't sleep soundly because of my lung condition
I have lots of energy	(0) (1) (2) (3) (4) (5)	I have no energy at all
		SCORE
		[Empty box for score]
		TOTAL SCORE
		[Empty box for total score]

COPD Assessment Test and CAT logo is a trademark of the GlaxoSmithKline group of companies.
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 <p>Canterbury Clinical Network Transforming Health Care. Whānau Ora ki Waikato.</p>	<p>COMMUNITY RESPIRATORY SERVICES</p>
<h2 style="margin: 0;">Community Pulmonary Rehabilitation Outcome Survey</h2> <h3 style="margin: 0;">Pre-Programme</h3>	
<div style="border: 1px solid #ccc; padding: 10px; background-color: #f9f9f9;"> <p>Date: <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> Name: <input style="width: 150px;" type="text"/> <input style="width: 150px;" type="text"/></p> <p style="text-align: center; font-size: small;">day month year Surname First Name</p> <p>NHI: <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> Date of Birth: <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/></p> <p style="text-align: center; font-size: small;">day month year</p> </div>	
<p>By placing a tick in one box in each group below, please indicate which statements best describe your own health state today.</p>	
<p>1. Mobility</p> <p>I have no problems in walking about <input type="checkbox"/></p> <p>I have some problems in walking about <input type="checkbox"/></p> <p>I am confined to bed <input type="checkbox"/></p>	<p>2. Self-Care</p> <p>I have no problems with self-care <input type="checkbox"/></p> <p>I have some problems washing or dressing myself <input type="checkbox"/></p> <p>I am unable to wash or dress myself <input type="checkbox"/></p>
<p>3. Usual Activities (e.g. work, study, housework, family or leisure activities)</p> <p>I have no problems with performing my usual activities <input type="checkbox"/></p> <p>I have some problems with performing my usual activities <input type="checkbox"/></p> <p>I am unable to perform my usual activities <input type="checkbox"/></p>	<p>4. Pain/Discomfort</p> <p>I have no pain or discomfort <input type="checkbox"/></p> <p>I have moderate pain or discomfort <input type="checkbox"/></p> <p>I have extreme pain or discomfort <input type="checkbox"/></p>
<p>5. Anxiety/Depression</p> <p>I am not anxious or depressed <input type="checkbox"/></p> <p>I am moderately anxious or depressed <input type="checkbox"/></p> <p>I am extremely anxious or depressed <input type="checkbox"/></p>	
<p>PTO</p>	
EQ-5D pre programme.doc	Version 1
16/07/09	

To help people say how good or bad a health state is, we have drawn a scale (rather like a thermometer) on which the best state you can imagine is marked 100 and the worst state you can imagine is marked 0.

We would like you to indicate on this scale how good or bad your own health is today, in your opinion. Please do this by drawing a line from the box below to whichever point on the scale indicates how good or bad your health state is today.

**Your own
health state
today**

Best
imaginable
health state

100

90

80

70

60

50

40

30

20

10


0

Worst
imaginable
health state

Appendix I: Physiotherapy Assessment Sheet

NAME: _____

NHI: _____ GENDER: _____ DOB: _____ AGE: _____



**Canterbury
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PULMONARY REHABILITATION PHYSIOTHERAPY ASSESSMENT

Exercise and Mobility
Date

Walking Aids

☐ None ☐ Walking Stick ☐ Walking Frame

Falls History: _____

Comments: _____

Musculoskeletal Conditions

Current Exercise

Exercise Tolerance / ADLs / Activity Limitation

Chest Clearance

Cough: _____

Sputum: _____

Comments: _____

Breathing Pattern

History of Chest Infections

Previous Chest Physiotherapy

☐ No ☐ Yes Comments: _____

Referrals Generated

☐ Respiratory Physiotherapy Outpatients
☐ Musculoskeletal Physiotherapy Outpatients
☐ Falls Prevention
 Other: _____

☐ Older Persons Health Physiotherapy
☐ Green Prescription

Appendix J: One-minute Sit-to-stand sheet



Sit – to – stand test results

PARTICIPANT NAME _____

Date \ \

Programme code _____

Test #1

End number of Stands _____

End number of rests _____

End recovery time _____ minutes

	Baseline	End
SpO ₂		
Heart rate		
BORG FATIGUE	_____	_____
SOB		

Further comments: _____

Signature

Designation

Name

One-Minute Sit-to-stand Test

A 46-48cm height armless chair was used for the STST. Participants were instructed to keep their legs shoulder-width apart with approximately 90 degrees knee flexion, placing hands on hips, laps or across the chest to eliminate upper limb assistance.

A practice STS was performed to ensure safety and familiarity with the movement. The standard verbal instructions were

“The sit-to-stand test will go for one minute. You should do as many repetitions as possible at a speed you are comfortable with. When you are standing up, you should not be using the arms for support. You can have short breaks as needed.”

Initiation of the test began with **“attention, ready, go”**;

participants were reminded when there was 15 seconds of the test remaining and when to stop.

One repetition comprised full knee extension in standing followed by a controlled return to a seated position. Any partial repetitions were excluded from the result.

Appendix L: Borg scale of exertion

0	None
0.5	Very, very light
1	Very light
2	Light
3	Moderate
4	A little severe
5	Severe
6	
7	Very Severe
8	
9	Very, very severe
10	Maximum

Appendix M: Phone call protocol:

Would you establish with the participant which phone number to use first? Would they always have a cell phone and land line? Land line first then cellphone

Is it Ok with the participant to leave a message if they are unavailable? yes

If another member of the family answers the call what would you say? Preferable to speak to the patient direct.

How many attempts would you make? maximum 3!

1. Call home number
 - Answer- offer encouragements to continue with breathing exercise and exercise regime, document on MedTech
 - No answer
 - Voice box- leave a message to encourage exercise and breathing ex, document on Medtech
 - No voice box- try mobile phone number
2. Call mobile phone number
 - Answer- offer encouragements to continue with breathing exercise and exercise regime, document on Medtech
 - No answer
 - Voice box- leave message to encourage exercise and breathing ex, document on Medtech
 - No voice box- document on MedTech

Standardised conversation prompts

- “Hello this is xxx calling from the home-based breathing exercise programme, how are you?”
- “How did the breathing exercise and the DVD ex go in the last week?”
- “How can we make your exercise experience better, if any?”
- “This week, we will briefly talk about XXX from the little blue book you have got”

Finished off by saying...

- “I would encourage you to continue with the exercise regime as much as you feel comfortable with. Next week we will talk about XXX from the little blue book. I will catch up with you again next week!”
- “Take care, bye!”

Home-Based pulmonary rehabilitation flowchart

